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THE CHEMICAL NEWS,

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CONTRIBUTIONS TO THE HISTORY OF BLEACHING-POWDER.*

By GEORGE LUNGE, Ph.D., Professor of Technical Chemistry, Zurich.

CHLORIDE of lime, or, as it is more commonly called, bleaching-powder, is a product of chemical manufacture which has for a long time past attracted the attention of chemists, not merely on account of its commercial importance, but also because its very chemical nature is to a great extent shrouded with far more mystery than we are accustomed to encounter, especially among inorganic compounds. It is even doubtful up to this moment whether we have to deal here with a true chemical compound only more or less mixed with accidental impurities, or whether it is from the process of its manufacture a mechanical mixture of several chemical compounds in certain proportions. The statements of the numerous investigators of bleaching-powder (which name I prefer to "chloride of lime," as not prejudging the question of its constitution) deviate from each other not merely in theoretical points, which would be natural enough, but also upon certain matters of fact, which should admit of a definite decision by means of experimental enquiry. In order to settle the fact as to some of the most important points in dispute between different chemists, I have, with the co-operation of one of my pupils, Mr. Schäppi, made an investigation, the results of which are summarised in what follows.

I shall not in this case, as is otherwise usual, set out with an enumeration of the literature on the constitution and formation of bleaching-powder—both because it would prove a very lengthy task and because the subject is very fully discussed in the third volume of my "Treatise on the Manufacture of Sulphuric Acid and Alkali," to which I must refer those who are more closely interested in the matter.

Our investigation touched the following points :—

I. What is the influence of the percentage of water in the lime on the formation of bleaching-powder?

II. What is the influence of air on bleaching-powder at high temperatures?

III. What is the action of carbon dioxide on bleaching-powder?

IV. How does the water contained in bleaching-powder behave?

* A Paper read before the Newcastle-upon-Tyne Chemical Society, November 25, 1880.

I. *Influence of the Percentage of Water on the Formation of Bleaching-Powder.*—Two points are at issue here. First. Whether it is true that absolutely dry calcium hydrate does not absorb any chlorine? Second. With what percentage of water in the lime the strongest bleach can be made? With respect to both of these questions the statements of different chemists disagree most seriously. (The strongest bleach made in these experiments served for many of the later sets).

The lime for these experiments we endeavoured in the first place to prepare by calcining the purest Carrara marble in a Hessian crucible; but it proved very difficult to regulate the temperature so as to drive out nearly all the CO_2, without "burning" the lime "dead." Owing to this we preferred to use selected pieces of lime produced on the large scale, the analysis of which (made after slaking) proved its great purity:—

CaO	72·62
CO_2	0·51
Al_2O_3	0·06
SiO_2	not weighable
H_2O	27·80
	100·99

In a series of further estimations, made for each special chlorination, the CO_2 never exceeded 0·7, nor did it fall below 0·2 per cent

The following apparatus served for the treatment with chlorine. A circular plate of strong sheet-lead, 12 inches diameter, was provided with a double upright rim, 2¼ inches deep. The annular space between the two rims was filled with sulphuric acid of specific gravity 1·4, at which strength the acid neither absorbs nor gives up any sensible quantity of moisture at the ordinary temperature. A bell jar with a tubulated top dipped with its lower rim into the sulphuric acid, thus forming a hydraulic lute. The tubulus was provided with an india-rubber cork through which passed two glass tubes; one reaching half way down the bell jar, for introducing the chlorine; the other, ending just beneath the cork, for conveying the air and the excess of chlorine into a condenser charged with calcium hydrate and coke. Inside this apparatus the lime was spread in thin layers on flat glass dishes, sometimes only in one at a time, sometimes in several dishes separated from each other by a glass framework.

The percentages of water in the following are understood as comprising the water of hydration. The latter in pure CaO,H_2O amounts to 24·32 per cent; for the lime employed by us it is as nearly as possible = 23·5 per cent.

The treatment with chlorine was always continued till no further absorption took place, as judged by the colour of the gas; the apparatus was then left to itself over night. The analyses were always made at least twice over, several times even more frequently, especially in the cases where strikingly high results were obtained.

a. Chlorine, completely dried by concentrated sulphuric acid, yielded the following products:—

Percentage of water in the lime employed.	Percentage of available chlorine in the bleach.
6·5	9·06
13·6	32·86
13·64	33·34
17·6	37·38
17·6	37·64
21·6	38·82
24·0	40·71
26·0	40·89
27·8	43·13
27·8	43·42
28·2	40·36
30·1	38·78
31·8	36·85

The following five samples were chlorinated at the same time under the same bell-jar, so that presumably the lime poorer in water attracted some of the water in the last sample:—

Percentage of water in the lime.	Available chlorine in the bleach.
6·5	12·49
13·6	35·38
21·6	40·18
24·0	43·09
41·0	20·34

b. Chlorine incompletely dried, by passing it through a tube, 3 feet 3 inches long, filled with dry pumice. This mechanical absorption of the water was intended to imitate as nearly as possible the superficial method of drying employed in the factories, where the gas is passed through a long range of pipes in which most of the water, along with the hydrochloric acid, is condensed by the cooling action of the air. In either case the chlorine contains at least the moisture corresponding to the existing temperature and pressure, and the result must be very nearly the same in both cases.

Water in the lime.	Available chlorine in the bleach.
24·0	42·12 per cent
26·0	41·59 ,,
28·2	40·54 ,,

c. Chlorine dried still less, viz., washed by water of 15° C. (59° F.), and passed at once into the bell-jar:—

Water in the lime.	Available chlorine in the bleach.
20·0	34·47 per cent
24·0	41·76 ,,
26·0	40·71 ,,

d. Damp chlorine, passed through water of 40° C.:—

Water in the lime.	Available chlorine in the bleach.
24·0	38·26 per cent
26·0	38·27 ,,
26·0	39·31 ,,

e. Damp chlorine, passed through water of from 75 to 80° C. (167° F. to 176° F.):—

Water in the lime.	Available chlorine in the bleach.
24·0	37·0 per cent
25·3	38·43 ,,
26·0	38·96 ,,

This bleach was no longer a dry powder, but was damp and lumpy.

These samples, treated once more with damp chlorine as before, did not become richer, but somewhat poorer in available chlorine.

f. Calcium hydrate, dried on the water-bath, containing 24·0 per cent H_2O, chlorinated along with ordinary slaked lime, containing 25·3 per cent H_2O, yielded—

	With perfectly dry chlorine.	With chlorine merely dried by pumice.
Lime with 24 p. c. H_2O..	39·3	41·59 p.c. available Cl.
,, 25·3 ,, ..	40·6	40·6 ,, ,,

These experiments lead to the following conclusions:—

1st. The statement of Graham, Tschigianjanz, Fricke and Reimer, and others, *that perfectly dry calcium hydrate does not absorb any chlorine, is erroneous.* This agrees with Stahlschmidt and Kopfer. Free water is quite unnecessary in order to start the reaction; on the contrary, even in the presence of a large excess of $CaO,Ca(OH)_2$ absorbs a large quantity of dry chlorine, much more even than if the CaO present had to be considered as useless ballast. This is probably caused by the liberation of water in the reaction:— $CaO_2H_2+Cl_2=CaOCl_2+H_2O$; even if the bleaching compound itself should be a hydrate, which is not certain, the assumption is not excluded that it might be deprived of its water of hydration by the stronger affinity for it of calcium oxide.

2nd. *The strongest bleaching-powder can be made with dry chlorine* up to 43·42 per cent available chlorine. Damp chlorine, even when freed from HCl by washing, is not quite so good, but bleach of 42 per cent can be made even when merely superficially drying the chlorine by a 3 feet 3 inch passage through pumice, somewhat corresponding to the long ranges of pipes employed in factories.

3rd. *The strongest bleach is made when the total moisture amounts to about 4 per cent over and above the water of hydration of the lime.* When employing dry chlorine, this 4 per cent must be contained in the lime itself; with imperfectly dried chlorine, as in experiments (*b*) and (*f*), the lime should contain less, only about 0·5 to 1·0 per cent free water. That this conclusion actually applies to the conditions of manufacturing on the large scale is proved by thoroughly trustworthy information which I received from Mr. Schaffner, the manager of the celebrated Aussig works. There the moisture in the sifted lime is determined every day; in summer it is kept at 24·5 to 25, in winter at 25·5 per cent; the latter, because then the chlorine itself loses more moisture in the 200 feet of piping through which it has to pass. There is never any irregularity to speak of in the strength of the bleach obtained. Whilst formerly German bleach was usually weaker than English, now the trade reports state that the German consumers allow a somewhat higher price for home-made than for English bleach, because the former is more uniform in quality. Hence the exact regulation of the amount of water is evidently of the utmost importance in bleach-making. It could be so regulated with the greatest accuracy, if it was feasible on the large scale to work with dry chlorine and to introduce the lime with the precise amount of moisture; at least we, on the small scale, *invariably* obtained bleach of 42 to 43 per cent under these conditions.

4th. The statement made by a few observers, that stronger bleach is made when passing the gas through warm water, is certainly erroneous.

5th. Since bleaching-powder of 43 per cent available chlorine is always obtained, when working under the above conditions, no formula can be correct which involves less available chlorine than 43 per cent.

II. *Influence of Air on Bleaching-powder.*—The substance was exposed to air in a porcelain boat within a horizontal glass tube, which could be heated to any desired constant temperature by means of an air-bath, provided with a gas regulator. The thermometer was fixed close to the plac

where the boat was, but evidently its indications must have been somewhat higher than the real temperature within the tube. One end of the latter was connected with a receiver containing a solution of potassium iodide, and a cylinder filled with water for receiving the residual gas. This cylinder was fixed with its mouth downwards; the tube conveying the gas passed through its cork and went right to the top, whilst a second tube, ending just above the cork and closed outside by a pinch-cock, served for aspirating the air and the gases by means of the outflowing water, and for transferring the residual gas into a Winkler's gas-burette. The other end of the horizontal tube containing the bleaching-powder was also provided with a pinch-cock; here the air could be introduced directly, or washed and dried. For those experiments where air saturated with moisture was to be employed the horizontal tube was provided with a side branch connected with a small flask containing water, and kept at the same temperature as the bleaching-powder tube, in the same air-bath

a. Experiments with moist air.—The bleaching-powder tested 43·09 per cent. After heating for two hours at 60° C. (140° F.) no sensible evolution of gas had taken place, but this commenced at 80° C. (176° F.) and was finished a little above this temperature, so that further heating at a higher temperature did not produce much effect. The escaping gas contained no chlorine or hypochlorous acid, but merely oxygen. The residue in the boat, when the heating had lasted long enough, showed no available chlorine at all, but 39·42 Cl as chloride and 2·99 as chlorate. The latter must have retained as much oxygen as corresponds to 14·95 $CaOCl_2$; the free oxygen is evolved by a splitting-up of the remaining $CaOCl_2$ into $CaCl_2$ and O. The assumption that all the oxygen comes from a secondary decomposition of the first-formed calcium chlorate is not excluded; but there is no reason why a direct splitting-up of $CaOCl_2$ should not be admitted.

b. Dry air, passed over bleach of 43·09 per cent at 38° to 42° C. for 44 hours. The escaping gas contained no sensible quantity of oxygen (except that of the air itself), but 4·73 per cent of the bleach as chlorine. In the residue there was 3·99 per cent Cl as chloride, 0·23 as chlorate, 34·78 as available chlorine.

c. Dry air, passed over bleach of 42·70 per cent at 100° to 105° C. for six hours. The escaping gas contained 0·87 per cent of the bleach as oxygen (corresponding to 3·86 Cl as $CaOCl_2$) and 14·94 per cent as chlorine; the residue contained 22·25 per cent chlorine as chloride, 3·51 as chlorate, 1·35 as available chlorine.

The experiments (II.) prove the following:—

1st. In *damp* air of about 80° C., bleaching-powder gives up much oxygen; all the chlorine remains in the residue, partly as chloride, partly as chlorate. The reactions are:—

$$CaOCl_2 = CaCl_2 + O \text{ and}$$
$$6CaOCl_2 = Ca(ClO_3)_2 + 5CaCl_2.$$

2nd. In *dry* air of about 100° C. bleaching-powder yields the same products as in damp air; but another portion of the bleaching compound is directly split up into lime and chlorine:—

$$CaOCl_2 = CaO + Cl_2.$$

III. *Treatment of Bleaching-Powder with Carbon Dioxide.*—The apparatus was similar to that employed in the preceding series; but there was no aspiration, the CO_2 (moist or dry) being introduced on one side, and the gases passing out of the other side, first through a potassium iodide receiver, in order to retain the Cl, then into a measuring tube for the gas, luted by a solution of sodium hydrate and provided with a stop-cock at the upper end. In this tube the oxygen was collected and afterwards submitted to analysis.

a. Dry CO_2 of the ordinary temperature was passed many days in succession over bleach of 43·09 per cent and of 32·8 per cent not specially dried. At first a very slight quantity of Cl (or ClOH) was given off, probably only so long as any moisture was present; then the action ceased, and nearly all the chlorine was found unchanged (in the available state) in the residue.

b. Dry CO_2 was passed over bleach from various sources *at higher temperatures*, with the following results:—

	Chlorine Escaping as such. Per cent.	Chlorine in the Residue. As Available. Per cent.	As Chloride. Per cent.	As Chlorate. Per cent.
Laboratory bleach of 43·09 p.c., treated 40 minutes at 95 to 100° C.	34·20	1·31	6·14	1·00
English bleach of 34 p.c. (originally 39 p.c.), 1 hour at 100° C.	28·28	2·47	5·67	?*
The same, 2½ hours at 70 to 75° C. ..	30·48	0·34	4·98	0·74
The same, 3½ hours at 55 to 60° C. ..	25·3	—	—	—
The same, 2 hours at 70° C.	29·21	—	—	—
The same, 2 hours at 70° C.	28·41	—	—	—
The same, 2 hours at 70° C.	27·50	—	—	—
Swiss bleach of 34 p.c., 2 hours at 60° C., then ½ hour at 100° C.	29·75	0·58	3·45	0·89

c. Dry carbon dioxide, passed over bleaching-powder which was previously *thoroughly dried* by long standing over concentrated sulphuric acid, caused no change at the ordinary temperature. At 80° C. 2·66 per cent chlorine was given off; at 180° C. no chlorine, but much oxygen, evidently merely by the action of the heat itself.

d. Moist CO_2, acting on English bleach of 34 per cent at 70° C., evolved in an hour 29·58 per cent chlorine.

e. Calcium chloride, treated at 70° C. with CO_2, exactly like the above samples, did not yield a trace of chlorine. This was to be expected as a matter of course; but the check test was made in order to exclude any doubt whatsoever.

After all these results the conclusion seems unavoidable, *that no formula of bleaching-powder in which calcium chloride occurs can be correct*, since in the presence of as little moisture as is contained in strong bleach nearly all the chlorine is driven off at 70° C. by carbon dioxide. The small quantity of chlorine found in the residue as chloride is evidently partly free $CaCl_2$ already present in fresh bleach, partly that produced in the formation of a little chlorate. That in the absence of all moisture the action is very slight is no matter of surprise; but even very much moisture would not explain how calcium chloride can be decomposed by CO_2 with formation of free Cl. The matter is different in the case of bleach *solutions* where the compound $CaOCl_2$ seems to have split up into CaO_2Cl_2 and $CaCl_2$ (we have not ourselves gone into that question yet); here there is a *possibility* that CO_2 might drive off so much ClOH that its action on KI would equal that of the Cl just found, although it would contain only half the quantity of chlorine. But even in that case a corresponding quantity of $CaCl_2$ would be found in the residue, which our experiments distinctly disprove to be the case for *solid* bleach.[1] Hence the formulæ of Gay-Lussac, Kolb, Fresenius, Stahlschmidt, &c., are all impossible, whilst Odling's formula $Ca\begin{matrix}-Cl\\-OCl\end{matrix}$ suffices for explaining all the phenomena observed, and must be considered the right one.

IV. *Behaviour of the Water contained in Bleaching-Powder.*—The substance was contained in a boat within a glass tube, which was heated by a flat mouthed burner,

* There was chlorate present, but the estimation miscarried. With these small quantities the chlorate could not in any case be quite accurately estimated.

a slight current of perfectly dry air being aspirated through it all along. The water driven off was absorbed by a calcium chloride tube, the chlorine by a solution of KI, and the escaping oxygen was in one case estimated by analysing the gaseous residue containing the aspirated air.

a. Bleaching-powder heated to incipient fusion :—

	Water.	Chlorine.	Oxygen.
34 per cent English bleach yielded ..	16·33	8·49	4·01 per cent
Do.	16·54	7·64	— ,,
Do.	14·60	9·39	— ,,
Do.	16·51	5·41	— ,,
Do.	17·60	6·40	— ,,
Do.	16·00	5·47	— ,,
Do.	18·09	7·49	— ,,

b. Bleach heated to the fritting point yielded 17·56 water; the same sample *heated with sodium carbonate* (as Stahlschmidt prescribes) yielded another 2·98 water, altogether 20·54 water, along with 7·67 per cent chlorine. Other samples of the same bleach were heated above the temperature employed before; after fritting the mass effervesced, evidently by the decomposition of chlorate, and then entered into a tranquil fusion. The glass tube (which was not of the most refractory kind) was softened, but the porcelain boat itself never got beyond a low red heat. In several experiments of this kind more than 20 per cent of water was driven off directly without adding sodium carbonate, which Stahlschmidt states to be necessary. A third sample of the same bleach was heated in a refractory glass tube, and yielded :—

In the air-bath at 150° C ..	14·21 per cent	H_2O
,, ,, 200 ,, ..	0·29 ,,	,,
,, ,, 290 ,, ..	1·12 ,,	,,
At a bright red heat	5·35 ,,	,,
	20·97 ,,	,,

The laboratory-made bleach of 43·09 per cent, treated in a similar manner, of course yielded less water, viz. :—

At 180° C	12·24	12·29	11·98
At a red heat ..	4·79	4·86	4·95
	17·03	17·15	16·93

These experiments are incompatible with Stahlschmidt's theory, according to which the bleaching compound contains two-thirds of the water as water of hydration, and one-third as hydroxyl, his formula being :—

$$2Ca\begin{matrix}-OH\\-OCl\end{matrix},H_2O + CaCl_2.$$

The hydroxyl is supposed to be eliminated in the shape of water only by fusion with sodium carbonate. But, as we see, all the water can be driven off by heating without sodium carbonate, and that *without* observing an interruption in the rate of escape when just two-thirds of the water have gone away. It is true that the greater proportion of water goes away below 150°; then a pause ensues in which very little water escapes, the remainder going away above 290° C. But this behavior is identical with that of calcium hydrate, as proved by the following experiment. On heating slaked lime, containing altogether 31·5 per cent H_2O, there escaped :—

Below 150° C.	9·33 per cent	H_2O
Between 150 and 290° C. ..	0·80 ,,	,,
From 290° C. to red heat ..	21·24 ,,	,,
	31·37 ,,	,,

Since the calcium hydrate was not absolutely pure, and a little carbonate was present as well, it is evident that the mechanically absorbed water escaped below 150°, the water of hydration only above 290°.

This seems to allow the conclusion, aided by the previous experiments, that the water driven off from the bleach above 290° C. belongs to *free calcium hydrate*, mechanically mixed with the bleaching compound ("chloride of lime"), whilst the water escaping at a lower temperature nearly all below 150° C., is either hygroscopicmoisture, or belongs to a hydrate of the compound $CaOCl_2$, or is partly one and partly the other. The strongest bleach obtained yielded only very little water above that necessary for the compounds $CaOCl_2H_2O$, and $Ca(OH)_2$. But on standing over sulphuric acid at the ordinary temperature not merely all mechanically absorbed water, but over a portion of the H_2O of the hypothetical hydrate, $CaOCl_2H_2O$, is lost. Hence the existence of this hydrate, which is also disputed by Opl and Kopfer, is at least very doubtful.

The analysis of very good laboratory bleach yielded :—

39·89	per cent	CaO.
43·13	,,	available chlorine.
0·29	,,	Cl as $CaCl_2$ (corresponding to 0·07 O).
17·00	,,	H_2O (average of three estimations).
0·42	,,	CO_2
100·73	,,	(less 0·07 for oxygen).

From this the following composition can be computed :—

$CaOCl_2$	88·08 per cent
$CaCO_3$	0·96 ,,
$CaCl_2$	0·45 ,,
$Ca(OH)_2$	6·74 ,,
H_2O (by difference)	3·77 ,,
	100·00

The actual determination of the water yielded 0·66 more.

The comparatively small percentage of calcium hydrate found, viz., one-seventh of the calcium present as $CaOCl_2$, would seem to make it unnecessary to take it into account in a formula of bleaching-powder. From many other analogies there would be no difficulty in assuming that a certain quantity of calcium hydrate, varying according to circumstances, escapes the attack of the chlorine through being mechanically enveloped by the much larger bulk of the proper bleaching compound, $CaOCl_2$. Possibly the latter is somewhat protected against decomposition, (*e.g.*, by the atmospheric CO_2), by the calcium hydrates mechanically mixed with it, so that the part played by the latter is not an unessential one; but this would not lead to an alteration of Odling's formula on that account. The circumstance that good bleach, when ground up with a little water, swells up with evolution of heat, could be easily explained by the fact, that in this process $2CaOCl_2$ are changed into $Ca(OCl)_2 + CaCl_2$, which two compounds are assumed by most chemists to exist in *solutions* of bleach.

On the hand, there is one circumstance which would tend to show that the excess of lime should be represented in the formula of bleaching-powder. When the strongest bleach is ground up with water and the mixture is then diluted the insoluble residue does not appear in the pulverulent shape to be expected of previously formed, unchanged calcium hydrate, but in a flaky, voluminous form, similar to calcium hydrate just precipitated from a compound. This behaviour could be easily understood with Stahlschmidt's formula ($2CaOHOCl = CaO_2Cl_2 + CaO_2H_2$), but as we have seen, there are other insurmountable difficulties militating against this formula. Hitherto we have not found a sufficient explanation for this behaviour; but further experiments will be made in this direction.

Nitration of Salicylanilide.—C. Mensching.—This nitro-salicylanilide has been obtained by treating salicylanilide with nitric acid, melting at 244°. If the compound is treated with alkalies, and if the nitro-salicylic acid formed is isolated and converted into a barium salt, there is obtained the salt of α-meta-nitro-salicylic acid.—*Ber. der Deutsch. Chem. Ges.*

ON CHICKEN CHOLERA: STUDY OF THE CONDITIONS OF NON-RECIDIVATION AND OF SOME OTHER CHARACTERISTICS OF THIS DISEASE.*

By M. L. PASTEUR.

Concerning the properties of the extracts of the artificial cultivation of the germ of chicken cholera, an inquiry presents itself. We have shown that these extracts contain no substances capable of preventing the cultivation of the germs of this disease. They might, however, contain elements adapted to the vaccination of chickens. To investigate this point I have prepared cultivations where volume was not less than 120 c.c. After filtration and evaporation at a low temperature, while infinite care has been taken that its purity should not be affected, this liquid has given a dry extract, which was re-dissolved in 2 c.c. of water, and the totality of this was injected under the skin of a chicken which had never had chicken cholera. A few days afterwards the chicken, after being inoculated with a virus of the greatest virulence, died with the usual symptoms of *unvaccinated* chickens.

This class of experiments led to the following observation, which is of the greatest importance in physiology: When the extract from the cultivation of the germ of this disease, corresponding to an abundant development of the parasite, is injected under the skin of a fresh chicken in perfect health, the following phenomena take place: At first the chicken seems to suffer from a nervous disorder, which is indicated by panting breath and alternately opening and closing its beak; afterwards it becomes motionless, assumes the shape of a ball, refuses food, and seems overcome with drowsiness, as is the case with chickens affected with the disease. There is this difference, however, that the chicken wakes up at the least noise. This sleep lasts about four hours, after which the chicken wakes up, looks as well as usual, eats and cackles as if nothing had happened to it.

I have repeated this experiment several times and have always observed the same facts. Before injecting the extract above-mentioned, I took in every case the precaution of injecting an extract of the pure chicken broth, which does not cause analogous phenomena. I have, by this means, acquired the conviction that, during the life of the parasite, a narcotic is formed, and that it is this narcotic which causes the morbid symptom of sleep so characteristic of the disease which we are studying.

By the acts of its nutrition the germ of the disease causes grave disorders and brings on death. The germ, being aërobian, absorbs during its life large quantities of oxygen, and burns up many of the elements of its medium of cultivation. This may be seen by comparing the extract of the broth, before the development of the germ, with the extract of the liquid in which the development has taken place. Everything seems to show that it is from the globules of the blood that the oxygen necessary to its existence is derived by absorption through the tissues. While the chickens are still alive, even when death is still far off, their combs assume a violet tinge at a time when the germ of disease is so little diffused through the blood that it escapes microscopical examination. This species of asphyxia is one of the most curious traits of the disease we are studying. Death is caused by the grave disorders brought about by the development of the parasite in its body, by pericarditis, by serous extravasations, by alterations of its internal organs, by asphyxia, but the sleep characteristic of the disease is caused by a product formed during the life of the germ, which acts on the nervous centres. The independence of these two effects in the symptoms of this disease is further established by the fact that the extract from a filtered cultivation of the germ acts as a narcotic on chickens which have been submitted to the *maximum* degree of vaccination.*

These facts will, doubtless, be found worthy of the meditations of pathologists.

Although I have taken already much of its time with this subject, the Academy will allow me to call its attention to some other characteristics of the disease called *chicken cholera*. We know that this disease is rapidly fatal, particularly if caused by a direct inoculation of its germ. It must then appear extraordinary that it sometimes presents itself in the chronic state, as in the case of inoculated chickens; which, after being severely ill, do not die, but seem to get relatively better. They eat, however, very little; they become anæmic, as shown in the discolouration of their combs; they continue to lose flesh, and finally die, after lingering for weeks or months. This fact would not be of primary importance if, at the death of the chicken the germ of the disease was not, in most cases, found in its body, which conclusively proves that the parasite has been present since the last inoculation, always active, although in a mild form, for it brings on death slowly. Doubtless, the germ was placed in some *vaccinated* portion unfavourable to its cultivation. Vaccinated chickens are most apt to present this form of disease, which is of very rare occurrence. We might be led to believe that, in this case, the virulent virus is changed into the attenuated, but this would be an error. In cases of this kind the virulence of the germ of the disease seems, on the contrary, to be aggravated. This may be easily seen by cultivating it artificially, so as to separate it from the blood, and inoculating it on fresh chickens.

Facts of this kind help us to understand the possibility of those long incubations of virus, such as that of rabies, for instance, which, after existing a long time in the body in a state which may be called latent, suddenly manifest their presence by the most marked virulence and by death. Do not these facts also throw light on human pathology?

Alas! how often we see virulent diseases, such as scarlatina, measles, typhoid fever, followed by serious disorders of long duration, which are frequently incurable? The facts to which I have called attention are of the same nature, only here we can put our finger on their true cause.

I will conclude by pointing out another peculiarity, which is not less worthy of the attention of the medical profession.

In chickens in perfect health which have been thoroughly vaccinated there often occurs an abscess full of pus on some portion of the body, which does not seem to have any injurious effect on the health of the animal. It is a remarkable circumstance that this abscess is due to the germ of chicken cholera, which remains in it as in a closed vessel, and it cannot propagate, doubtless, because the chicken has been vaccinated. This germ may be withdrawn by artificial cultivation, or it may be directly inoculated on fresh chickens, which it kills in the usual manner after an abundant development. These facts recall the abscesses on guinea-pigs, which I have mentioned in the first communication on this subject, and they furnish a rational explanation of what happens in these abscesses. In all likelihood the muscles of the guinea-pig cultivate the germ more slowly and with greater difficulty than those of chickens; the disease is limited to an abscess, and recovery becomes possible.

I will now conclude this statement, as I have no wish to wear out the patience of this Academy. This subject is, however, so vast and so fruitful that I will ask its permission to bring the subject before it again. I have other observations to present to these. I will add those which will present themselves in the investigations I am now making.

* Translated from the *Comptes Rendus de l'Academie de Sciences*, of May 3rd, 1880, by P. Casamajor. The translation of the second paper of this series appeared in the Chemical News, vol. xlii., page 321 (December 31st, 1880).

* I should, however, try to isolate the narcotic, and see whether a sufficient quantity could cause death, and whether, in this case, the internal disorders would be the same as those of the disease itself.

"We would give nothing to the public," says Lavoisier, "if we waited until we reached the end of our researches, as these become broader and more extended the farther we advance."

A CRYSTALLISED DOUBLE SULPHATE OF LIME AND SODA.

By CHARLES W. FOLKARD.

In the Welsh process of manufacturing acetate of soda, during the evaporation of the liquor formed by the double decomposition of acetate of lime and sulphate of soda, a salt separates out in the form of micaceous spangles, which are greasy to the touch like steatite. They are of a light brown colour, due to tarry compounds dissolved in their mother-liquor. After removal of adhering acetate by alcohol, pressing between blotting-paper and drying over chloride of calcium, they have the following composition:—

	By Analysis.	Theory.
Ca	14·1	14·39
Na_2	16·8	16·55
$(SO_4)_2$..	68·7	69·06
	99·6	100·00

The above constituents were determined directly in the ordinary way, the loss being in part due to a trace of acetic acid, no doubt present as acetate of soda, which would account for the sodium being high. There was also a little water (0·3 per cent), probably in the form of mother-liquor in the interstices of the crystals.

On gentle ignition the salt is unchanged, but on heating to bright redness the crystalline form is destroyed. This seems strange, as it is anhydrous, and the bases and acids are fixed. It is probably due to the decomposition of the interstitial acetate of soda, the steam, &c. produced, possibly causing disruption of the crystals. At all events it seems difficult to account for the fact in any other way.

The salt is insoluble in alcohol and in concentrated solutions of acetate of soda, but is decomposed by weak solutions and by water.

Its formation is an essential part of the manufacture, and, therefore, an excess of sulphate of soda must be added to the acetate of lime solution. Sulphate of lime, being soluble to a certain extent in acetate of soda liquor, is not entirely precipitated in the double decomposition. This dissolved portion combines with the excess of sulphate of soda during the boiling down, and is precipitated as the double salt under consideration. It is in the form of mud (which sparkles in the sun, from the bright spangles of $CaNa_2(SO_4)_2$ which it contains), as soon as the liquor is sufficiently concentrated. If, however, there be no excess of sulphate of soda present, the dissolved sulphate of lime separates out in a jelly-like form on evaporation, and interferes altogether with the crystallisation.

If the separated mud be treated (preferably before cooling, as the strong solution crystallises into a solid mass) with methylated alcohol, it is found to consist of the crystalline double sulphate mixed with concentrated solution of acetate of soda. The greater part of the latter can be washed away by the alcohol, but the crystals always retain a little acetate of soda (about ½ per cent), doubtless, as mother-liquor between their layers, and from the very conditions of its formation and existence the salt cannot be purified from it.

On treatment with water or solution of acetate of soda of sp. gr. 1·150 and under, the salt is decomposed into sulphate of soda, which passes into solution and sulphate of lime, the latter, however, still containing soda.

The formation of this salt may explain why sulphate of lime obstinately retains sulphate of soda in double decomposition, which is only partially extracted even by boiling water. This is a source of considerable loss in certain manufacturing operations.

I have not been able to find any description of a salt of this composition crystallised in plates, although Watts mentions two or three double sulphates of lime and soda. An analogous compound of potassium and calcium is formed during the evaporation of tartaric acid liquors. It was described by Mr. Geo. H. Ogston, and contains—

$$K_2Ca(SO_4)_2.\tfrac{1}{2}aq.$$

Although the double sulphate of lime and soda is mentioned by Muspratt as being formed in the manufacture of acetate of soda, there is no description of it anywhere, so far as I am aware, and therefore it seemed to me that a short note on the subject might be of interest.

Ealing, December 28, 1880.

ON A THERMAL BALANCE.*

By Prof. S. P. LANGLEY.

Prof. Langley commenced, on the part of the Allegheny Observatory, with an account of a new instrument, invented by him and used there for measuring radiant heat, such as that from the sun or moon, or a distant terrestrial object. It was intended to replace the thermopile, which was used with effect by Melloni 40 years ago, but which had been little improved since, and was now insufficient for the numerous important investigations modern science needed in this direction. This new instrument, which he called provisionally "The Thermal Balance," was founded on a well-known principle, viz., that an electric current could be diminished by warming the wire through which it passed. Pyrometers on this plan had been made by Siemens and others. Nearly a year's experiment, however, had gone to producing the instrument exhibited, in which a quite new application of this principle had been made. Using a thermopile no power exists to move the index of the galvanometer, except the feeble energy which lies in the ray which warms the pile. In the new instrument a relatively powerful battery is employed, and the feeble radiant energy acts, not by its own weak force, but by controlling this great battery power, just as a weak human hand might control enormously greater power than its own when laid on the throttle valve of a steam engine. The thermal balance consists essentially of two series of delicate strips of excessively thin steel, platinum, or palladium, through which two equal currents pass. These opposite currents meet in a galvanometer, whose needle, pushed in opposite ways, by two equally powerful forces, remains motionless. Warming one of the sets of strips, by an almost inconceivably small amount would, it was shown, diminish the flow of electricity through the strips so warmed, and alter the index. As little change as a fifty-thousandth part of a Fahrenheit degree could be thus detected; and what was important, the instrument was not only far more sensitive than the thermopile, but far more prompt and very precise. Prof. Langley illustrated its delicacy by the statement that if placed in the reflecting telescope, it would indicate the heat from a man or other animal in a distant field. Except as far as the radiant heat might be absorbed by the air, it would, when thus directed, register that emitted by a cow, horse, or man at the distance of a quarter of a mile. As a more practical evidence of its utility to physicists, Prof. Langley gave tables of results in repeating Melloni's experiments' showing that the probable error of even a single measure in the latter case was less than 1 per cent., and concluded by an exhibition of measures on the heat of the moon made by it under the most diverse conditions, to test its real trustworthiness by this most delicate investigation.

* Abstract of a paper read before the National Academy of Sciences, New York.

ON THE

MEASUREMENT OF RADIANT ENERGY.*

By Prof. S. P. LANGLEY.

In this paper Prof. Langley gave an account of some theoretically interesting results, reached by his thermal balance in measurements on the solar spectrum. No pure spectrum can be obtained by a prism owing to the absorption of the rays by its own material, but all the attempts of physicists to measure the exact distribution of energy in what is a pure spectrum, viz., that formed by what is called a "reflecting grating," had been hitherto baffled by its feeble character. Yet the question involved was of great theoretical importance, being nothing less than that of an experimental proof of the identity of heat and light, as merely different manifestations of the same radiant energy. Dr. John W. Draper, giving expression to the conception already in the minds of advanced thinkers long since, not only asserted this identity, but maintained, in opposition to almost universal authority at that time, that the heat and light curves were substantially identical; that heat did not give a maximum in the ultra-red, and that were it possible to make precise measures these facts could be demonstrated by methods more conclusive than any which were then known enabled him to use. Mr. Lewis M. Rutherfurd, of this city, had, by his extraordinary success in making accurate "gratings," surmounted one great part of this difficulty. He had generously put his rare skill in this direction at the service of any student of science who could profit by it, and it was, therefore, to him that they were largely indebted for the means of thus experimentally demonstrating the truth of Dr. Draper's views. The exact conclusions of the research undertaken by him must, Prof. Langley said, be deferred. It was now clear, however, that the curves representing the distribution of heat and light in the spectrum were substantially coincident, and the statements of eminent European authorities, who had taken too little account of American men of science, as represented by such names as those of Rutherfurd and Draper, must now be modified.

QUALITATIVE SEPARATION OF COBALT AND NICKEL.

By F. REICHEL.

The circumstance that the detection of small quantities of cobalt in presence of nickel is tedious induced the author to utilise the solubility of the oxides of cobalt in concentrated potassa lye for this purpose.

If, in the course of analysis, a precipitate is obtained which may contain cobalt and nickel, it is not possible, if the nickel preponderates, to demonstrate the presence of cobalt by a simple blowpipe experiment. It is necessary to dissolve the precipitate, to add potassium nitrate, or to precipitate cobalt, if present, as hydroxide by means of a current of chlorine, and the subsequent addition of barium carbonate—an operation which requires several hours.

The author recommends to dissolve the precipitate, to throw down both metals with potassa lye, and place the precipitate on a filter. After the liquid is run off the precipitate, without washing, is introduced into a test-tube; a fragment of caustic potassa and very little water are added, and the whole is brought to a boil. The more concentrated the potassa solution the easier is the separation. The cobalt dissolves with a blue colour, and even very small quantities may thus be detected. The mixture is immediately filtered through a small asbestos filter, which should be in readiness, washing first with hot concentrated potassa lye and then with water. From the filtrate the cobalt may be precipitated as hydroxide by the addition of ether.—*Zeitschrift fur Analyt. Chemie.*

* Abstract of a paper read before the National Academy of Sciences, New York.

ON THE

GRAVIMETRIC METHOD OF DETERMINING PHOSPHORIC ACID.

By Dr. B. PEITZSCH, Dr. W. ROHN, and Dr. P. WAGNER.

The authors recommend the following process, which has proved satisfactory in the experience of five years.

From 25 to 50 c.c. of the solution of the phosphate, which may contain from 0·1 to 0·15 grm. P_2O_5, are placed in a porcelain capsule with the addition of 100 to 150 c.c. molybdic solution. The mixture is heated on the water-bath, with occasional stirring, to about 80°, set aside for an hour, filtered through a plain filter, and the yellow precipitate (which need not be entirely rinsed on to the filter) is washed with dilute molybdic solution. The porcelain capsule is then placed under the funnel, the filter is pierced with a platinum wire, and the precipitate is washed into the capsule with dilute ammonia (2½ per cent), washing the filter-paper well, dissolved, stirring with the glass rod, and the solution washed into a beaker with ammonia of the same strength, enough of which is added to make up a volume of 100 c.c. About 15 c.c. of magnesium chloride mixture are then gradually dropped in, constantly stirring. After the mixture has been set aside for two hours, covered with a glass plate, it is filtered through a plain filter, the weight of the ash being known, and the precipitate is washed with dilute ammonia of the same strength till a portion of the filtrate, after being acidulated with nitric acid does not show the presence of chlorine with silver nitrate. The dried precipitate is separated from the filter, placed in a porcelain crucible; the paper is charred but not incinerated, and the char placed in the crucible, which is heated first gently, then ignited strongly for 10 minutes in a slanting position over a Bunsen burner, and finally exposed for 5 minutes to a blast-flame, let cool in the exsiccator, dried, and weighed.

The first 6 or 8 c.c. of the magnesia mixture should be added very cautiously.

The final ignition before the blast serves to volatilise any traces of molybdic acid which may have been precipitated.

The molybdic solution, dilute molybdic solution, and magnesium mixture should be prepared as recommended in the *Zeitschrift fur Analytische Chemie*, 12, 239.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, December 14, 1880.

E. W. Binney, F.R.S., F.G.S., President of the Section, in the Chair.

"*The Land Subsidence at Northwich*," by Thomas Ward.

Having been an eye-witness of the great subsidence of land at Northwich, on December 6th, I will endeavour to explain how it arose. The district, of which Northwich is the centre, has two beds of rock salt underneath it. The first one, about 40 yards from the surface, is on the average 25 yards thick. Below this there is a bed of much indurated clay, about 10 yards thick, and below this again the bed of lower rock salt, some 35 yards thick. From 1670 to 1780 all the rock salt mined was obtained from the "Top Rock," as it is locally called, and the miners left too few supporting pillars, and these not large enough, besides working the salt out so as to leave only a comparatively thin crust of salt as a roof. The great majority of the mines in the Top Rock salt have fallen

wholly or partially. Since 1780 the rock salt has been "got" from the lower bed, and the pillars, especially of late years, have been left much larger, the roof at the same time being much thicker. Only from 5 to 6 yards of salt near the bottom of the bed has been worked. As a rule the mines in the bottom rock salt have stood firm, and where the owners have worked to their boundaries they have allowed the brine to run into the worked-out mines, thus converting them into reservoirs. The quantity of rock salt mined is small compared with the white salt manufactured. The white salt is made from a natural brine, which is found on the surface of the "Top Rock." It is found much cheaper to let the water do the mining and then pump up the salt in solution and drive off the water. The fresh water, as soon as it reaches the rock salt, eats it away till it gets fully saturated. This water running over the roofs of the old "Top Rock" mines has, in numbers of cases, eaten the whole of the salt away and opened a communication into the mine below. The overlying clays and earths, being deprived of their support, fall into the cavity thus opened, and a hole is made from the surface. On December 6th this was what occurred, and a hole or rift opened right across the course of the Wincham Brook, the water immediately rushing below. As the mines in both "Top" and "Bottom" rock were nearly exhausted of brine, the cavities to be filled were enormous. Directly beneath where the fall occurred, and bordering on an old-abandoned Bottom Mine, was a rock salt mine being worked. The barrier between the two having been on two occasions penetrated, it now gave way, and opened a communication with 15 acres of mine having a worked-out depth of about 18 ft. Into this mine, down a funnel of 100 yards in length from the surface, the water rushed with great velocity, causing the lower portion of the brook to retrace its course and drain off a large body of water from the River Weaver and an adjoining lake called the Top of the Brook. This immense body of water, rushing into the underground cavities, drove out the air contained therein, and so violent was the compression of the air, that it forced its way through every portion of the contiguous district that was in the least rifted or weak, showing itself in violent ebullitions in all the neighbouring pits, and where the earth was fractured causing a number of miniature mud geysers of 10 to 12-ft. in height. Much property was seriously damaged, and a considerable piece of land covered with water. Five sets of salt works are stopped owing to the destruction of a road and the pipes conveying the brine from the pumping district to the works. The greatest sufferers by this subsidence had little to do in causing it, and this is one of the great anomalies of the system of obtaining salt. The property of numbers of persons in no way connected with the salt trade is seriously injured, and under the existing law no compensation can be obtained.

This great subsidence is interesting from a geological point of view, as showing the action of natural forces, and illustrating how change of surface may occur. A counterpart of the Old Salt Lake of Triassic times is in process of formation.

"*Some endeavours to ascertain the nature of the insoluble form of Soda existing in the residue left on Causticising Sodium Carbonate Solutions with Lime*" (Part II.), by Watson Smith, F.C.S., Assistant Lecturer on Chemistry in the Owens College, and Mr. W. T. Liddle. Communicated by Professor C. Schorlemmer, F.R.S.

At the close of our last paper we mentioned that it was our intention to try certain further experiments with the crystalline precipitate obtained by mixing solutions of sodium carbonate and lime water and warming, and also with ordinary "*lime mud*" from the causticising pan of an alkali works, after the usual washing and draining. The experiments we proposed to try were:

(1) The effect of ignition upon the crystalline precipitate prepared as above, and upon the "*lime mud*" of the soda works.

(2) The effect of long continued boiling with water.

(3) The effect of boiling with some saline solution, as for example, with sodium sulphide.

Two fresh samples of the crystalline precipitate were now prepared, each in rather a different manner from the other. In the first case lime water was used in slight excess, and the sodium carbonate solution was dilute; in the second a strong solution of sodium carbonate was employed, the sodium carbonate being in excess. The precipitates obtained in both cases appeared under the microscope similarly crystalline; we will call them A and B respectively. On analysis the following results were obtained, after the precipitates had been washed with hot water till quite free from all soluble alkali:

	A.	B.
Calcium carbonate ..	98·07 per cent.....	98·11
Sodium carbonate ..	1·93 ,, ...	1·88
	100·00	99·99

(1) A weighed quantity of dried precipitate, previously well washed from all soluble alkalinity, was now ignited strongly for about an hour, subsequently treated with dilute spirits of wine (water and alcohol, 5 : 2) filtered, washed well, any little lime in the filtrate precipitated, again filtered, washed, and the filtrate finally evaporated to dryness and weighed. Thus it was found that every trace of soda was extracted from the substance, both by examining the perfectly white sodium carbonate obtained, qualitatively, and also the residue of calcium carbonate with the spectroscope. The weight of Na_2CO_3 extracted was found to be 2·00 per cent, closely agreeing with the amounts determined. (See above analyses, A and B.)

(2.) A weighed quantity of the crystalline precipitate was now subjected to a six-hours' continuous boiling with water, adding water from time to time to replace that evaporated. By this means 1·7 per cent Na_2CO_3 was extracted, leaving about 0·2 per cent Na_2CO_3 in the residue, which the six-hours' boiling therefore failed to remove. The residue on spectroscopic examination showed that soda still remained behind. Doubtless another hour's boiling would entirely remove it.

(3.) The effect of boiling for six hours with a solution of sodium sulphide, obtained by lixiviating the mass resulting after fusing a mixture of ordinary salt-cake and charcoal, showed us that by this means much less soda is extracted than when pure water is used. The six-hours' boiling extracted only 0·5 per cent Na_2CO_3, thus leaving about 1·4 per cent insoluble in the residue. The crystalline precipitates we obtained as described were anhydrous, as the analyses show.

With regard to the *lime-mud*, the soda insoluble in water, and which long washing with hot water could not remove, was found in another sample of the mud to be 2·10 per cent Na_2CO_3, the amount of soluble alkali = 2·62 per cent, giving a total content of soda as—

2·10 per cent Na_2CO_3 insoluble
2·62 ,, ,, soluble

4·72 ,, ,, total.

The water in the lime-mud was estimated by heating to 110° in a current of hydrogen till a constant weight was obtained. Thus 34·6 per cent of water was found, and calculating now on *dry residue*, we get as—

Na_2CO_3 insoluble, 3·21 per cent
,, soluble, 4·00 ,,

,, total 7·21

(1.) After first washing a weighed quantity of the lime-mud, passing CO_2 to convert any lime into carbonate, and washing again to remove soluble alkali, the residue was ignited for an hour strongly, and then after a thorough washing with dilute alcohol, precipitation of any dissolved lime in filtrate, determination of soda obtained, and spectroscopic examination of residue, we found all soda was

thus removed. This result agrees with that obtained by ignition of the precipitates we prepared. Kynaston found the same many years ago, in some examinations of lime-sludge, and hence we can quite confirm his results.

(2) The experiment was now tried of boiling a weighed quantity of the mud (having first passed CO_2), for six hours continuously with water, from time to time replacing what was lost by evaporation. The whole was now filtered and washed thoroughly, the filtrate being carefully evaporated to dryness. The residue gave a slight soda reaction in the flame, and was dissolved in hydrochloric acid, lime, and other bodies precipitated (a little iron and alumina with ammonia, and the calcium as oxalate), and then this filtrate was also evaporated to dryness. By this means it was found that practically all the soda was extracted by the prolonged boiling, the amount left behind being inappreciable.

It may now be interesting to mention that Fritzsche in 1864 (*Journ. für Prakt. Chem.*, 93, 339) succeeded in obtaining crystals artificially of the body till then only known as a mineral under the name of "*Gay Lussite*." These crystals he obtained by the action of a boiling solution of sodium carbonate upon a smaller quantity of a solution of calcium chloride of 1·13 sp. gr., and letting the whole stand for some days. The analyses of these crystals showed them to consist, as Gay-Lussite does, of $CaCO_3,Na_2CO_3 + 5H_2O$. On heating with water the body is decomposed, sodium carbonate being dissolved and calcium carbonate being left behind. It was also found that the salt, when dehydrated, is more easily and quickly decomposed by water than before dehydration, and it would appear in fact as if the calcium carbonate and sodium carbonate were simply held together by the water of crystallisation.

When Fritzsche came to analyse the crystalline body he obtained, he attempted it by washing out the sodium carbonate, igniting the residue of calcium carbonate, and weighing the calcium oxide remaining after the ignition. On testing the residue by solution in very little hydrochloric acid, a very small evolution of carbon dioxide was observed, and this led to further examination, resulting in the discovery of a small quantity of sodium carbonate which had remained insoluble with the calcium carbonate. Fritzsche promised to experiment further in this new direction, but it does not appear that he has. Nevertheless, the results he obtained show that in two experiments the quantities of sodium carbonate retained as insoluble in the calcium carbonate residue, after careful washing, were, (1st) 1·8 per cent, (2nd) 2·4 per cent, thus closely agreeing with the amounts we found in our crystalline precipitates, the anlayses of which are given above.

Of course we are aware that several speculations might be advanced to account for the occurrence of the soda in the calcium carbonate in the insoluble form, but it seems to us most in accordance with the results we have obtained, with others, to view it as combined with an equivalent proportion of calcium carbonate, an insoluble compound being formed.

The practical bearing of our results would seem to be upon (1) the "causticising process," and (2) on the "black ash" process of the soda manufacturer, In the first case, as already mentioned, the residual soda is kept in circulation in the process, and so is not lost, the lime-mud being drained, and used again in the black-ash mixture. In some works, however, where black-ash is not made, *e.g.*, soap works, causticising from soda-ash, &c., an average loss of about 7¼ per cent Na_2CO_3 of the dry residue, or 4·7 per cent of the washed and well-drained mud, is sustained. In the second case, it is evident that an adequate improvement, by which a minimum amount of calcium carbonate is used in the black-ash mixtures, must effect an improved yield of soda or lixiviation, a smaller retention as insoluble compound in the soda-waste occurring. Wright's results and remarks on this head are valuable. (See his paper, already cited—Part I).

NOTICES OF BOOKS.

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and of Alkali, with the Collateral Branches. By George Lunge, Ph.D., F.C.S. Vol. III. London: John Van Voorst.

We have here before us the third and last volume of Dr. Lunge's great and valuable work. Here he discusses the ammoniacal soda-process, the manufacture of soda from cryolite, and gives an account of the applications of soda, and the statistics of the trade. Turning then to the most important of the secondary products, he considers the manufacture of chlorine by the ordinary process and the preparation of bleaching-powder. He next passes in review a variety of other processes for the manufacture of chlorine, and describes the proposals for the utilisation of still-liquor. The celebrated improvements of Weldon and Deacon form the subject of two chapters. We have next an account of various bleach-liquors, such as the chlorides of potash, alumina, magnesia, &c., compounds which, though possessing certain advantages, have not come into very extensive use. Dr. Lunge then treats of the analysis of bleaching compounds, by the processes of Gay-Lussac, Graham and Otto, Bunsen and Wagner, Penot and Davis. The tenth and last chapter is devoted to the chlorates of potash. There are two appendices, one giving an estimate of the cost of erecting an alkali works, with ground-plan, &c., and the second comprising addenda to the three volumes.

Certain portions of the work must now claim more especial attention. No small importance is naturally to be accorded to Dr. Lunge's verdict on the ammonia process. Supposing that the plant and apparatus required could be everywhere obtained in perfection, would the manufacture of soda by the Leblanc process have to cease? It is admitted that the soda made by Solvay himself is cheaper than soda of equal strength made in the same place. "But," remarks Dr. Lunge, "in England it appears that the ammonia-ash can only compete with the ordinary ash owing to its superior quality, which causes it to be saleable at a considerably higher price where purity is a first object. Where the latter is not of such importance the ordinary alkali securely keeps its place in this country as yet. He points out, further, that the manufacture of caustic, which cannot be well combined with the ammonia process, has risen to great importance, and cannot be lightly abandoned. Soda crystals also are made more readily by the old process, now that the cyanide and sulphide can be almost completely removed from the tank-liquor.

In Germany and France the author considers that the Solvay process will spread to a tolerable extent, especially where strong brine-springs exist near coal formations. But on the other hand, have to be considered the bulkier state of the Solvay soda and the non-production of hydrochloric acid. The former of these obstacles, Dr. Lunge thinks, will probably be got over, but as yet there is no promise of making hydrochloric acid cheaply from calcium or magnesium chloride. Hence, where the cost of alkali and hydrochloric acid together is higher by the Solvay than by the Leblanc process, the latter will still predominate. It is further remarked that recently the German alkali makers have learned to turn out their ash *fully* equal in colour and strength to the best ammonia ash." Parenthetically, we beg to ask whether our English manufacturers have been equally successful?

It is also urged that a very great extension of the Solvay process would cause a very serious rise in the price of ammonia. In the best-managed works on the new system the loss amounts to 5 per cent. of ammonium sulphate on the total soda produced. If we take the total production of soda in Great Britain at 450,000 tons, and consider that, according to the calculation of Prof. Roscoe, the yield of ammonia obtainable from all the gas-liquor in

the island is only 9000 tons, we shall see that, were the Solvay process to become universal, the cost of ammonia would soon reach a prohibitive figure. As regards the various proposals for obtaining ammonia artificially from atmospheric nitrogen, it may be said that none of them can yet be pronounced fully successful from a commercial point of view. Hopes may, perhaps, be entertained concerning Rickman's process.

The Weldon process is described very thoroughly and with full appreciation of the inventor's merit. The author states that 90 per cent. of all the bleaching-powder manufactured in Great Britain is made on the Weldon method, and on the Continent it prevails exclusively, save in one establishment in Germany where the Deacon process is at work.

The Deacon process, simple and beautiful as it seems, has not in the long-run given satisfactory results. It is mentioned that a manufacturer, who had laid out £16,000 in plant for this process, was compelled to discontinue it. The favourable reports he heard of the working at Messrs. Gaskell, Deacon, and Co.'s establishment led him to pay a visit of examination at the end of 1878, but what he saw had not the effect of inducing him to re-commence. The process is said to be in successful use in a Berlin factory for making chlorate of potash, but none of Mr. Deacon's apparatus is employed.

It is, we think, impossible to read through this work carefully without nothing the enormous strides which, within the last sixteen years, have been made by chemical manufactures in France and Germany. The author remarks, in his preface to the present volume, that when he first left his native country for England "the manufacture of sulphuric acid, soda-ash, and bleaching-powder was quite insignificant in Germany and not very considerable in France, as compared with Great Britain, nor could the technical appliances, the yields, or even the purity of the products in the two former countries vie with those of the latter. How different matters are now is a matter of notoriety. Many of the chemicals of those countries outstrip those of English works in purity; and their plant and their processes are frequently superior to those used in the majority of English works. Everybody knows how this has come about. The foreign chemists and manufacturers have looked all round, not merely in their own countries, but wherever they could find improved methods and apparatus; and, upon the practical knowledge thus gained, they have brought to bear the scientific training they had received at their universities and polytechnic schools. Thus they have already, in many fields formerly remunerative to British manufacturers, distanced the latter, immensely aided though these be by their long occupation of the ground and by permanent natural advantages, such as cheapness of coal and freight, superior command of capital; and this is likely to go on to an increasing extent if many British chemical manufacturers decline to profit from a scientific study of their respective branches. This is all the less excusable as England from of old has been a stronghold of scientific chemistry, and can hold its own against the whole world in this respect."

Might it not be worth our while to lay to heart these words of a friendly foreigner?

An exceedingly valuable feature of Dr. Lunge's work, in our opinion, is that he lays before his readers the methods of manufacture practised in France, Germany, Austria, and Belgium, as well as those followed in Britain. Another merit is that, whilst giving its due importance to practice, he does not overlook theory. He remarks, somewhat drily, that "several costly books, on perhaps the most important branch of chemical industry, has just been published with next to no chemistry in them." We hope that Dr. Lunge's work will be studied in the same spirit in which it is written, so that his readers, whilst looking for "practical hints," will not neglect fundamental principles.

The Atomic Theory. By Ad. Wurtz. Translated by E. Cleminshaw, F.C.S., F.I.C. London: C. Kegan Paul and Co.

If we compare the present work with that of Daubeny on the Atomic Theory, now long ago superseded, we shall be able to see what real and also what imaginary advance has been made in the philosophy of chemistry during the last quarter of a century.

The illustrious author sets out with a historical introduction, in which the labours of Proust, Richter, and Dalton are duly appreciated. He next passes to Gay-Lussac's law of volumes, the hypotheses of Avogadro and Ampère, and to the corpuscular theory of Berzelius. We next come to a discussion of Prout's hypothesis, the law of specific heats as developed by Dulong and Petit; isomorphism and the atomic weights of Berzelius; the objections to his principle of notation and remarks on the inconsistencies of the "equivalent" notation. In his fifth chapter the author examines the present system of atomic weights as established by the labours of Gerhardt, Laurent, and Cannizaro. The sixth chapter may be considered the most important part of the entire work, as in it the author examines the "periodic" classification of the elements introduced by Mendeleeff and Lothar Meyer. We propose to furnish an abstract of his critique elsewhere. Next follows an account of H. Kopp's researches on the molecular volumes of salts. The second book deals with atomicity, beginning with the definition and historical development of the idea. Prof. Wurtz treats of affinity and atomicity as two distinct properties of atoms. He applies atomicity to the interpretation of isomers and of molecular dyssymmetry. The work concludes with a survey of hypotheses on the constitution of matter,—a question possibly beyond the scope of the human intellect. The author considers the conception of vortex atoms as of all hypotheses on the nature of atoms apparently the most probable. He considers the idea, however, as not absolutely new, but as having been originally conceived by Descartes. No one who aspires to an understanding of the more advanced chemical and physical speculation of the present day can afford to ignore this volume, which may be advantageously studied in conjunction with the opposite views of Prof. Kolbe and of the late Prof. Mohr, the representatives of what some may call the conservative phase of chemistry.

London Smoke and Fog; with some observations on the Country Parson's Grate and other Modern Fire-Places; being a chapter from the Author's new edition of his work on the Ventilation of Dwelling-Houses and the Utilisation of Waste Heat from Open Fire-Places. By Frederick Edwards. London: Longmans, Green, and Co.

We have here a small book, with a long title, on a very important subject. That London fogs are a nuisanee we all know, and even without the testimony of Dr. Carpenter, of Croydon, the public is not entirely ignorant that we may leave a village ten or twelve miles off with clear air and sunshine and enter gradually an atmosphere that is utterly repulsive." But where is the remedy?

In some matters we are rightly told that if every man would reform himself the whole would be reformed. But as regards the smoke question, only the man who has a permanent interest in the house he occupies, and who has a tolerable balance at his bankers, can reform himself. And such men are relatively so few that if they each and all adopted the most approved means of smoke-consumption the improvement in most parts of London would be inappreciable.

The author reviews the various remedies proposed, such as the use of gas and of anthracite as fuel, and the absurd scheme of a tax on all open fire-places. Absurd we call this suggestion, because the ordinary house-occupier has not the right, and in many cases not the means, to make the alteration.

He then brings forward a plan which we cannot view without very grave doubts. He revives, namely, the scheme of John Cutler and of Dr. Neil Arnot, of burning a fire from the top downwards, and apparently of feeding it from below. This method would, of course, require the remodelling of all the fire-places in a house. We should fear that to light fires on this principle would prove exceedingly difficult, and that there would be considerable trouble in using them for cooking purposes.

In several respects we have actually retrograded in the construction of fire-places. The old-fashioned grates had no iron about them, save the bottom and front bars; all else was fire-brick. The great object of a modern fire-grate-maker is to employ, and consequently to sell, the greatest possible quantity of cast-iron. The kitchen-ranges generally used throughout the south of England are deplorable, the oven being heated not from the bottom, but from the top. Nor can any praise be given to the so-called "kitcheners," where the fire-box is small and the fuel is burnt at a temperature more suitable for metallurgical than for culinary operations. They sin, further, in having the fire surrounded with metal in place of fire-clay.

In criticising the Norwich stove, Mr. Edwards remarks very justly "it may be said that the regulator should be carefully graduated by the housemaid after she has lighted the fire, but in all probability there is not one housemaid in a thousand, or perhaps a hundred thousand, who understands its use and cares anything at all about the matter." We suspect that these same remarks would be found applicable to his proposal of lighting a fire at the top. Not one housemaid in a hundred thousand could do it, or would be willing to try. The fact is that to reform our fires we should have to begin at the beginning. So long as our houses are run up by speculative builders, who make the walls too thin, and so long as the doors, window-frames, &c., are constructed of unseasoned wood, manipulated by trades-unionist carpenters, so long we shall be compelled to consume more fuel than would be otherwise necessary. If ever the day comes when master and man drop the modern principle of working as badly as they dare, other improvements will follow.

Lectures on Domestic Hygiene and Home Nursing. By Lionel A. Weatherley, M.D. London: Griffith and Farran.

This useful little work scarcely falls within our jurisdiction. The author gives a catalogue of some disinfectants in general use, and speaks well of all. He remarks that chloralum is not volatile, and cannot be used as an aërial disinfectant—statements which hold equally good concerning "Condy's Fluid." Who, by the way, is "Professor Franklyn," cited as recommending chloralum? We are not acquainted with any chemist of that name—a name which seems to require dissociation. The remark that disinfectants stand distinctly second to efficient ventilation is very just. Indeed, aërial disinfection is scarcely possible in an inhabited room. It is but too probable that long before all morbific matter, organised or otherwise, could be destroyed the human inmates would succumb.

We are glad to see that Dr. Weatherley puts in a timely word of caution against that deplorable mania of the day which would place the nurse on a level with or above the physician.

Memoirs of the Science Department University of Tokio, Japan, (Vol. II.) *on Mining and Mines in Japan.* By C. Netto, M.E., Professor of Mining and Metallurgy, University of Tokio. Published by the University.

It appears that when Japan was first thrown open to the commerce of the world, very exaggerated notions prevailed concerning its mineral wealth, especially as regards gold and copper. It has since been found that these ideas were ill-founded. The richest and most available deposits of both metals have long since been extracted, and though mining may still be carried on to advantage, ample capital and considerable patience will be required. The useful minerals now raised in Japan rank thus in the order of their importance: Coal, copper, silver, gold, iron, kaolin, petroleum, sulphur, lead, antimony, tin, cobalt, mercury, marble, jasper, agate, amber, and graphite. Nickel, zinc, and arsenic have not been found in sufficient quantities for industrial purposes. Coal is now exported to the extent of 160,000,000 catties (1 catty = 1⅓ lb. avoirdupois), but 47,396,160 catties are still imported. It is much to be deplored that charcoal-burning is carried on in a reckless and wasteful manner, and that the mountains are consequently becoming denuded, to the ultimate injury of the climate and of the productiveness of the soil. The exports include sulphur 1½ million catties and sulphuric acid 1,400,000 catties.

The author gives a description of the mining processes now in use, with figures of the mining, dressing, and metallurgical tools.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 5, 1880.

On Digallic Acid.—Hugo Schiff.—A reply to P. Freda. (See *Berichte*, xii., p. 33)

On Oxypropionic (Oxyacrylic Acid).—E. Erlenmeyer. —Not adapted for useful abstraction.

Di-iodopropylic Alcohol and a Mono-iodoallylic Alcohol.—H. Hübner and E. Lellmann.—The former of these compounds forms long colourless needles, easily affected by light and heat, soluble in water, insoluble in alcohol, and having the composition $C_3H_5I_2OH$. If the solution of this compound is heated in chloroform, the result is C_3H_4IOH, which crystallises in delicate needles, melting at 160° F.

Nitration of Paranitrobenzoic Acid to form a Dinitrobenzoic Acid.—H. Hübner and A. Stromeyer.—The authors have formed and examined dinitrobenzoic acid, and its barium, calcium, and magnesium salts, and have obtained a nitroamidic acid and certain derivatives, with the examination of which they are still engaged.

A new Synthesis of Phosphenyl Sulpho-Chloride.—H. Koehler.—Twenty parts phosphenyl-chloride were placed in a small flask with a reflux condenser, and five parts sulphur chloride were slowly added by means of a dropping-funnel. After the reaction is over, the flask is set in a freezing mixture of Glauber's salt and hydrochloric acid. Pale yellow crystals of phosphenyl-tetrachloride are formed, from which the liquid is separated by decantation, then shaken with water, dried, and rectified. The yield is almost quantitive.

Ortho-chlor-benz-paratoluide and its Derivatives.—H. Schreib.—The derivatives described are ortho-chlor-benz-meta-nitro-para-toluide, dinitro-ortho-chlor-benz-para-toluide, trinitro-ortho-chlor-benz-para-toluide, ortho-chlor-benz-amido-para-toluide, benzoylised ortho-chlor-benz-metamido-para-toluide, and anhydro-ortho-chlor-benz-metamido-para-toluide.

On the Relation of Molecular Weight and Density in the Gaseous State.—Alex. Naumann.—The author points out certain errors in a paper by Gustave Schmidt on the relative volumes of gases.—*Ann. Physik.* 1879, vi., 612.

Some Derivatives of Xylol.—R. Netzki.—An investigation of amidoazoxylol, para-xylendiamine, xyloquinone, and hydro-xyloquinone.

Action of Finely Divided Silver upon Monobrom-butyric-ethyl-ester.—Carl Hell and O. Mühlhäuser.—The action of silver upon monobrombutyric-ethy-lester is the similar to that upon the monobrom-substitution product of isobutyric ethpl-ester. The great number of products, the trifling yield of diethylsuccinic-ester, and the appearance of several of its isomers show that the reaction of silver with the brom-ester of a fatty acid is not very smooth, and does not consist in the mere elimination of the atoms of halogens.

On the Acids $C_8H_{14}O_4$ formed from Butyric Acid.—Carl Hell and O. Mühlhäuser.—Besides a volatile oily acid, probably identical with isocrotonic acid, there are formed by the reaction of siver and bromobutyric acid, two acids agreeing in composition with suberic acid, but distinctly different from each other, and from the two isomeric acids produced by a corresponding reaction with brom-isobutyric acid. There exist, therefore, five isomeric suberic acids.

More Particular Observations on the Action of Potassium Carbonate upon Isobutyl-aldehyd.—F. Urech.—The author placed about 3 grms. pure isobutyl-aldehyd in a narrow test-tube graduated in half millimetres. With a lens it was possible to read accurately quarter millimetres. After 3 decigrms. of finely-powered recently-ignited potassium carbonate had been added, the tube was closed, set in a horizontal position, and the level read off every five minutes for forty-eight hours. The liquid was found to have sunk from 21·50 to 14·50 degrees.

Further Notes on the Reaction of Potassium Cyanide and Sulpho-cyanide, Acetone, and Aqueous Hydrochloric Acid.—F. Urech.—The author names the compound produced acetonyl-sulpho-carbaminate. By acetonyl he understands the radicle of acetonic acid.

On Ballo's supposed Adipic Acid obtained from Camphor.—J. Kachler.—On oxidation with chromic acid camphor does not yield adipic acid, but the same oxidation-products as with nitric acid. Chromic acid, however, converts the camphoric acid first formed completely into members poorer in carbon.

Action of Iodethyl upon Iodacetic-ethyl-ester—L. Aronstein and J. M. A. Kramps.—The authors exposed molecular proportions of the above-mentioned substances to a temperature of 230° for several hours in a sealed tube. The chief result was ethylen iodide, along with acetic acid and unchanged ethyl iodide. No trace of butyric acid or butyric ethyl-ester was perceptible.

On γ-Sulpho-isophthalic Acid and the corresponding γ-Oxy-isophthalic Acid.—Karl Heine.—Not susceptible of useful abstraction.

The Formation-heat of Ammonia, of the Oxides and Acids of Nitrogen, and of the Nitrates.—Julius Thomsen.—The formation-heat of ammonia is 11,890 cal. The author gives tables of the formation-heat of nitrous and nitric oxide, nitrous acid, nitrogen dinoxide, nitric acid, and of the anhydrous nitrates. These tables the author wishes to be taken in place of *Berichte* tables 1 and 2 in his Memoir (xii., p. 2064).

On the Remarkable Reducing Properties of Potassium Ferrous Oxalate, and on some of the Reactions thus Produced.—J. M. Eder.—Ferrous oxalate is very permanent on exposure to the air, both in a wet and a dry state, and possesses very feeble reducing properties. The solution of ferrous oxalate in potassium oxalate, as well as the solid double salt, takes up oxygen greedily, and passes into potassium ferric oxalate. Its affinity for oxygen is equal to that of an alkaline ferrous hydrate, or of ammoniacal cuprous chloride, or of pyrogallic acid in an alkaline solution. The double oxalate exerts its reducing powers not merely in alkaline, but in neutral, and even acid solutions. The solution quickly reduces platinum chloride and silver nitrate to metal. Silver chloride, bromide, and iodide are reduced completely, but more slowly. Copper acetate is reduced very slowly to cuprous oxide, and even to metal. With the aid of heat mercuric chloride is reduced to metal. Recently precipitated Prussian blue is reduced to white ferro-cyan iron potassium. Indigo blue is reduced to white indigo, and solutions of sulphindigotic acid are rapidly decolourised.

A New Method for the Quantitative Determination of Ferrous Oxide in Presence of Organic Acids and of Cane-sugar.—J. M. Eder.—Already noticed.

Action of Alcohols and Phenols upon the Imid Chlorides of Acids.—O. Wallach and A. Liebmann.—Not adapted for useful abstraction.

On Oxal-ethyline and Chloroxal-allyline.—O. Wallach and G. Stricker.—A description of these compounds and of their more characteristic derivatives.

On Bases of the Oxalic Acid Series.—O. Wallach and Ernst Schulze.—The bases examined are chloroxal-ethyline, oxal-ethyline, chloroxal-propyline, and chloroxal-amyline.

Formation of Bases from Substituted Acid Amides.—O. Wallach and Iwan Kamenski.—The authors conclude that if a base is formed by the action of phosphorus pentachloride from a substituted amide of monobasic acids with a short carbon chain, two molecules of the amide enter into reaction in such a manner that hydrogen is derived from the hydrocarbon radicle pertaining to the acid, in order to form hydrochloric acid.

Remarks on the Previous Memoirs.—O. Wallach.—Not susceptible of useful abstraction.

Transformation of Azoxybenzol into Oxyazobenzol.—O. Wallach and L. Belli.—An isomer of azoxybenzol was obtained by treatment with sulphuric acid and dilution with water, when the new compound was obtained in the form of small garnet-red crystals.

Further Contributions to the Knowledge of the Thiamides.—O. Wallach.—A notice of methyl-iso-thiacetanilide, thiacet-methylanilde, thiacet-orthotoluidide, and thiacet-paratoluidide.

Velocity of the Substitution of Bromine in the Fatty Acid Series.—Carl Hell and Fr. Urech.—The authors give tables showing the progress of the reaction of bromine with the acetic and propionic acids, normal butyric and isobutyric acids, the valerianic, capronic, and caprylic acids. They recognise three successive stages: that of slow action, from the beginning of the application of heat till 10 to 20 per cent of the molecules of bromine present have entered into reaction, the stage of acceleration, which lasts until about 60 per cent of the bromine has acted, and the final stage of retardation, which lasts till the process is complete. The effect of the molecular magnitude appears in the first stage. In acetic acid 15 per cent of the bromine molecules present are substituted in 40 hours; in the next homologous acid this proportion is reached in 10 hours, in normal butyric acid in 7, and in isobutyric acid in 2.

New Colouring Matters.—W. V. Miller.—An examination of the colour known under the trade-name "Biebrich Scarlet." It appeared to be formed by diazotising so-called "acid yellow," and combining it with β-naphthol.

Homofluoresceine: a New Colouring Matter from Orcine and its Derivatives.—H. Schwarz.—On heating solutions of oreine with caustic alkalies and chloroform the liquid becomes purple and then fiery red, and on dilution shows a strong greenish-yellow fluorescence. This reaction is exceedingly sensitive. On neutralising and

adding bromine-water a compound is formed from the fluorescent colouring matter resembling eosine; its alkaline alcoholic solutions appear cherry-red by transmitted light with yellow fluorescence. The author describes homo-fluoresceine, its salts and derivatives. Though many of these compounds have splendid colours, only the nitro-derivatives are suitable for dyeing. Hexa-nitro-mono-oxy-homo-fluoresceine dyes silk a brilliant orange, the penta-nitro-diazo-amido-monoxy-homo-fluoresceine compounds a gold yellow and cyamic acid a light reddish-yellow.

Chemisches Central-blatt.

No. 26, 1880.

Coarse and Fine Superphosphates.—Fr. Farsky.—Finely granular superphosphate contains less soluble phosphoric acid than the coarse, and is less liable to reversion. For plants which stand close together, fine superphosphates are preferable to coarse sorts for such as are set at considerable distances.—*Listy Chem.*, 4, 161.

No. 27, 1880.

Density of Liquid Oxygen.—J. Offret.—The author has revised Pictet's calculation of the density of liquefied oxygen and considers the method inadmissible. His own calculation gives 0·840.

Explosive Antimony.—E. Mascarenas y Hernandez.—A solution of crystalline antimony chloride and hydrochloric acid at 1·12 sp. gr. was prepared so as to stand at 38° B. On electrolysis with the Lechlanché element there was obtained in twenty to twenty four hours a most explosive deposit.

Antimonial Cinnabar.—N. Teck.—The author prepared this compound by two methods. A solution of four parts tartar emetic and three parts tartaric acid in eighteen parts water at 60° was mixed with a solution of sodium hyposulphite and heated to about 90° (Wagner). Again, 4 vols. of antimony chloride of sp. gr. 1·19 were mixed with 10 vols. water and 10 vols. of a solution of sodium hyposulphite at 1·19 sp. gr., and heated very gradually to 55° (Mathieu Plessy). In each case the precipitate was well washed and dried. Antimonial cinnabar consists of homogeneous granules, in which no crystalline structure is perceptible.

A Colouring Matter from Carbon Disulphide.—C. Reichl.—If carbon disulphide is agitated with semi-fluid sodium amalgam, and if the paste-like mass is mixed with water, there is produced a hyacinth-red liquid, whilst mercury and mercury sulphide are deposited. The solution contains the sodium salt of a yet unknown acid, somewhat soluble in hot water, and more readily in alcohol. It dyes yellow, orange, and brown shades on wool and silk.—*Polyt. Notizblatt*, 35, 151.

Action of Oxalic Acid and Sulphuric Acid upon Naphthol.—M. Honig.—From *a* naphthol the author obtains a body which he names naphthanthraquinon. He is engaged with the further examination of this compound and of its derivatives.

Detection of Albumen in Urine.—H. Boedecker.—The urine is slightly acidulated with acetic acid, a few drops of potassium ferrocyanide are added, and a gentle heat is applied. If albumen is present, a turbidity appears followed by a flocculent precipitate.

Detection of pre-formed Urobiline in Urine.—E. Salkowski.—One hundred c.c. of urine are gently shaken up with 50 c.c. of perfectly pure ether; the ether decanted off and evaporated. The residue is taken up in absolute alcohol, and is rose-coloured with a green fluorescence. The experiment does not always succeed.

On the Crysalline Constituents of Corallin.—Carl Zulkowski.—This paper will, if possible, be inserted at length.

No. 28, 1880.

This number is devoted to an account of apparatus, scientific and industrial. None of the descriptions are capable of reproduction, as they would be unintelligible without the accompanying wood-cuts.

MISCELLANEOUS.

Royal Polytechnic Institution. — On Monday, December 27th, the Christmas entertainment commenced at this Institution. The programme is varied and entertaining. In his lecture on "Scientific Wonders," Mr. J. L. King described very fully the Photophone, and his description was made easier to understand by some very good illustrations. He then went on to explain and show several more interesting phenomena, such as Balmain's luminous paint, the lighting power of which is increased very considerably by treating with hot water. The affinity of different elements for each other was then pointed out and proved by experiments, of which the ignition of finely divided lead when placed in contact with the air may be taken as an example. Other experiments illustrating other chemical changes were shown, and much stress was laid on the change of colour of two solutions when added one to the other. In the Great Hall, some very pretty effects were produced by throwing the image of chromatic magic lantern slides on to a spray fountain. The entertainment altogether is interesting, as science and amusement are so well combined.

Society of Arts.—The dates for some of the papers which will be read at the Society of Arts before Easter next have been announced. The following are set down for the ordinary meetings (Wednesday evenings):—Jannary 12.—"A Sanitary Protection Association for London," by W. Fleeming Jenkin, F.R.S. (On this evening Professor Huxley will preside.) January 19.—"Causes of Success and Failure in Modern Gold-mining," by A. G. Lock. January 26.—"Five Years' Experience of the Working of the Trade Marks' Registration Act," by Edmund Johnson. February 2.—"Trade Prospects," by Stephen Bourne. February 9.—"The Present Condition of the Art of Wood-carving in England," by J. Hungerford Pollon. February 16.—"The Participation of Labour in the Profits of Enterprise," by Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge. February 23.—"Recent Advances in Electric Lighting," by W. H. Preece, Pres. Soc. Tel. Eng. March 2.—"Flashing Signals for Lighthouses," by Sir William Thomson, F.R.S. March 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper," by William Arnot, F.C.S. March 16.—"The Manufacture of Aerated Waters," by T. P. Bruce Warren. In the Indian Section (Friday evenings) the following will be read:—January 21.—"Forest Conservancy in India," by Sir Richard Temple, Bart., G.C.S.I. February 11.—"The Gold-fields of India," by Hyde Clarke. March 4.—"The Results of British Rule in India," by J. M. Maclean. March 25.—"The Tenure and Cultivation of Land in India," by Sir George Campbell, K.C.S.I., M.P. The dates and papers for the Foreign and Colonial Section (Tuesday evenings) will be:—February 1.—"The Industrial Products of South Africa," by the Right Hon. Sir Henry Bartle Edward Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., F.R.G.S., &c. February 22.—"The Languages of South Africa," by Robert Cust. March 15.—"The Loo Choo Islands," by Consul John A. Gubbins. April 5.—"Trade Relations between Great Britain and her Dependencies," by William Westgarth. For the Applied Chemistry and Physics Section (Thursday evenings), the arrangements are as follows:—January 27.—"A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda," by James Mactear. February 24.—"Deep Sea Investigation, and the Apparatus used in it," by J. G. Buchanan, F.R.S.E., F.C.S. March 24.—"The Future Development of Electrical Appliances," by Prof. John Perry.

MEETINGS FOR THE WEEK.

MONDAY, 10th.—London Institution, 5.
— Medical, 8.30.
TUESDAY, 11th.—Civil Engineers, 8.
— Medical and Chirurgical, 8.30.
WEDNESDAY, 12th.—Society of Arts, 8.
— Microscopical, 8.
THURSDAY, 13th.—London Institution, 7.
— Royal, 4.30.
— Royal Society Club, 6.30.
— Mathematical, 8.
FRIDAY, 14th.—Astronomical, 8.
— Quekett, 8.

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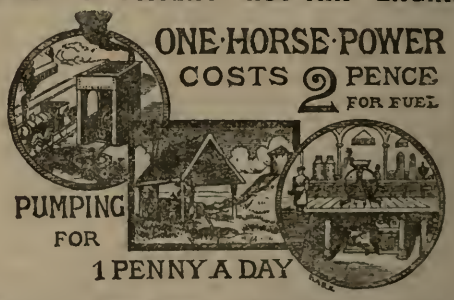

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1103.

ON THE HISTORY OF THE PERIODIC LAW.

By D. MENDELEJEFF.

As a reply to the claims of H. Lothar Meyer (*Berichte*, xiii., 259) respecting the discovery and development of the periodic law, I send, for the library of the German Chemical Society, two numbers of the *Journal of the Russian Chemical Society* containing my first printed original memoirs relating to the periodic law. Both appeared in 1869, and contain—1st, on pp. 60 to 77, my treatise read March 6/18, 1869, at a meeting of the Russian Chemical Society, and entitled "On the Relations of the Properties to the Atomic Weights of the Elements"; 2nd, on pp. 229, 230, a Report of the Second Congress of Russian Naturalists at Moscow, August 23, 1869, when I read a communication on the "Atomic Volume of the Elements." Both these memoirs appeared earlier than the treatise of H. L. Meyer (*Ann. Chem. Pharm.*, 1870, Supplement, vol. vii.), dated December, 1869, from which, according to him, I have "accepted as correct nearly everything which I (L. Meyer) had added to his (Mendelejeff's) researches," (*Berichte*, xiii., 263), and have "utilised facts without mentioning me (L. Meyer)."

From a translation of certain passages of my memoirs of March and August, 1869, which I here append, the inaccuracy of H. Lothar Meyer's contention will appear, the rather as he quotes an abstract from the *Zeitschrift f. Chemie*, 1869, p. 406, and the editor of that journal refers in this abstract to the original source, *i. e.*, to my memoir p. 60; hence the latter might have been known to H. L. Meyer.

The author here makes extensive quotations from his memoirs above mentioned, and resumes:—From these extracts it appears that, 1st, I had in March and August, 1869, expressed all the ideas which up to the present day represent the foundation of the periodic law; 2nd, that before me H. L. Meyer had not the periodic law in mind, and has added nothing new to it after me; 3rd, that H. L. Meyer, in advance of all other German chemists, was the first to comprehend the external side of the ideas concerning the periodic law; 4th, but had not penetrated the inner meaning of the periodic system after the appearance (1869) of my first memoirs, for in his paper, published in 1870 in the *Ann. Chem. Pharm.*, he repeats in a modified form what I had uttered before him, and left those phases of the subject (composition of the oxides, prediction of the properties of unknown elements, alteration of the atomic weights of Ce, Yt, Ur, &c.) which alone can serve to establish the correctness and universality of the law, undeveloped. These phases had to be explained by myself in the years 1870 to 1875, though they had been preliminarily touched upon in my first treatise (March, 1869). If anything new has been contributed to the development of the doctrine of the periodic law, it is due to Mr. Th. Carnelley, who has shown (*Berichte*, xii., 440; *Phil. Mag.*, Oct., Nov., Dec., 1879) that the melting-points and magnetic properties are periodically connected with the atomic weights.

I think I ought to mention that English journals (*e. g.*, *Phil. Mag.*, Oct., 1869, p. 310) maintain that Mr. Newlands (Chemical News, x., 59, 154, and xiii., 113) prior to me announced a law similar to the periodic, in 1864. I have hitherto not been able to obtain this volume of the Chemical News. Supposing, however, that our fundamental ideas were absolutely identical, and that the "investigation" for which H. L. Meyer is preparing (*Berichte*, xii., p. 261) turns out successful in this respect, I must point to the well-known examples that Kirchhoff and R. Meyer had prior to Lavoisier* expressed the ideas which nevertheless served as the foundation of the fame of this *savant*. That person is rightly regarded as the creator of a scientific idea who perceives not merely its philosophical, but its real aspect, and who understands so to illustrate the matter that everyone can become convinced of its truth. Then alone the idea, like matter, becomes indestructible. It is possible that Newlands has prior to me enunciated something similar to the periodic law, but even this cannot be said of H. L. Meyer. The present position of the question of elemental periodicity is not in the least indebted either to Mr. Newlands or H. L. Meyer.—*Berichte der Deutsch. Chem. Gesellschaft*, xiii., p. 1796.

THE HISTORY OF ATOMIC PERIODICITY.

By LOTHAR MEYER.

Contrary to my expectation, my note, printed on p. 257 of the *Berichte*, and as I believe very impersonal in its character, has drawn forth a violent reply from H. D. Mendelejeff. In order not to extend these lengthy explanations any further, I make merely the following remarks:—

What I wrote in December 1869, concerning the periodicity of properties I had found before the abstract of H. Mendelejeff's researches, published in the same year in the *Zeitschrift für Chemie*, fell into my hands. I claimed for myself, of course, merely matter which this abstract did not contain, or which in it seemed to require amendment. H. Mendelejeff now alleges that his memoirs, then published in the Russian language, contained all my additions and amendments, and blames me for not having procured the original documents. It seems to me too strong a demand that we German chemists should read, not merely the memoirs appearing in the Germanic and Romanic languages, but those also which are produced in the Slavic tongues and should test the German abstracts as to their accuracy.

H. Mendelejeff further considers my claim that, in his memoir published in *Liebig's Annalen*, 1871, he should have noticed my paper which appeared in 1870 in the same journal as quite unnecessary. I adhere to my view that he ought to have noticed it, even if not containing as much as he, according to his present statement, had recognised as valuable in an earlier Russian publication. He might thus have avoided the appearance of overlooking it intentionally and have saved us both the trouble of these explanations. Into the latter, I for my part would not have entered had I not been induced by the letter of M. Wurtz printed on p. 6 of the present volume of the *Berichte*. The accusation that I have not made sufficient reference to him could scarcely be brought in earnest by H. Mendelejeff (*Berichte*, xiii., p. 1798). No one probably has taken such pains to secure for the results of H. Mendelejeff's researches universal diffusion and recognition as I have done in the three editions of my "Modern Theories of Chemistry," which have since appeared.—*Berichte der Deutsch. Chem. Gesellschaft*, xiii., p. 2043.

PROF. WURTZ ON THE PERIODIC CLASSIFICATION OF MENDELEJEFF.†

Having given an exposition of this important and interesting arrangement of the elements from the pen of its author, and being about to notice the controversy now going on between Professors Mendelejeff and Lothar

* *Sic* in original.

† See "Wurtz on the Atomic Theory." London: C. Kegan Paul and Co.

Meyer, it becomes our duty to lay before our readers a brief summary of the criticism of Prof. Wurtz upon the periodic classification.

He remarks that the proposition of the great Russian chemist is not limited to any particular group of elements, but embraces all the elementary bodies. It is not confined to a consideration of certain analogies, but comprises all physical and chemical properties. It is a powerful generalisation, and must in future be taken into account whenever we regard the facts of chemistry from a lofty and comprehensive point of view. The attempt, however, still presents many imperfections, greatly due to the uncertain state of our present knowledge, especially as regards rare elements. Thus tellurium is not in its true place supposing its atomic weight to have been correctly determined. If it were the intermediate member between antimony and iodine it should have an atomic weight of about 125. It may also be asked whether copper is rightly placed, separated as it is from certain elements, *e.g.*, mercury, which it seems to resemble. Other bodies, such as cobalt and nickel, whose atomic weights are very similar if not identical, also give rise to a difficulty. According to the principle of the periodic classification their properties should also coincide, which is not the case, although they have many points in common. This also holds good with chrome, manganese, and iron, which are placed side by side in the same horizontal series, and between whose atomic weights there is very slight difference. On the other hand, there are wide differences between the properties of vanadium and bromine, between potassium and calcium, between rubidium and ruthenium, which are yet so closely related as to their atomic weight. It must further be admitted that the gradations of properties are far from progressing regularly or uniformly in the different groups. Sometimes they are too great, as in the first group, carbon, nitrogen, oxygen, and fluorine, and sometimes too small, as we have just remarked for the last terms of the third group. Though it may be generally true that the properties of bodies are subject to periodic modifications with the increase of their atomic weights, the law of these modifications escapes our observation, and seems to be of a compound nature; for, on the one hand, the atomic weights of successive elements vary within considerable limits without displaying any regularity in these variations; on the other hand, the gradations of properties—or, in other words, the greater or less divergencies between the properties of successive elements, do not appear to depend upon the degree of the differences between the atomic weights. In Mendelejeff's table we are chiefly struck with the gaps between two elements, the atomic weights of which show a greater difference than two or three units, thus marking an interruption in the progression of the atomic weights. Between zinc (64·9) and arsenic (74·9) there were two, one of which has been lately filled up by the discovery of gallium. But the considerations by which Lecoq de Boisbaudran was led in the search for gallium have nothing in common with the conception of Mendelejeff. Though gallium has filled up a gap between zinc and arsenic, and though other intervals may be filled up in future, it does not follow that the atomic weights of such new elements will be those assigned to them by this principle of classification. The atomic weight of gallium is sensibly different from that predicted by Mendelejeff. It is also possible that the future may have in reserve for us the discovery of a new element whose atomic weight will closely coincide with that of a known element, as do the atomic weights of nickel and cobalt. Such a discovery would not fill any foreseen gap. If cobalt were unknown it would not be discovered in consequence of Mendelejeff's classification.

Prof. Wurtz considers that Lothar Meyer has contributed a detailed and important development to Mendelejeff's ideas, showing that the physical properties of the elements are subject to periodic variations with the increasing value of their atomic weights. These facts as regards malleability, fusibility, volatility, and conductility for heat and electricity, Prof. Meyer has embodied in a graphic construction which appears at the end of M. Wurtz's work on the "Atomic Theory." In connection with this subject may be mentioned a relation pointed out by M. Lecoq de Boisbaudran between the atomic weights of bodies and their power of emitting luminous rays. He proves that for analogous bodies, such as potassium, rubidium, and cæsium; calcium, strontium, and barium; aluminium, gallium, and indium, the increase of atomic weight is proportional to the wave-length corresponding with the spectral lines of each metal. This idea led the way to the discovery of gallium, and it was even possible to calculate the atomic weight of this metal with those of aluminium and indium from the position of the corresponding spectral lines of the three metals.

VARIOLA, VACCINE, AND CHICKEN CHOLERA

By L. PASTEUR.

The following paper was read before the Academy of Medicine of Paris (meeting of June 1st) in answer to Drs. Guérin, Blot, and Depaul*:—

That variola and vaccine are deeply interesting to this Academy is what may be expected, as the discovery of vaccine is one of the greatest triumphs of medical science. I recollect the noble words of William Pitt, when urging before Parliament the bill to confer a national reward on Jenner.

"The House need have no fear that the reward shall be too great for the service rendered, for this cannot be exceeded. You may vote anything you please to the discoverer of vaccine, and you may be sure of universal approbation."

I need to refer to these great memories and to the feeling of respect due to this great discovery to understand, but not to justify, the emotion which, at the last meeting, overcame the minds of MM. Jules Guérin, Blot, and Depaul. I merely made a remark on the relations of the virus of variola to that of vaccine. I said that medical science was divided on the subject of the dependence or independence of these two viruses, and forthwith a tempest was raised. Messrs. Jules Guérin and Blot accused me of ignorance. M. Guérin referred me to the discussions which took place in this Academy in 1863 and 1864. M. Blot begged of me to go to the library to read these discussions, and that light would dawn on my mind. M. Depaul made me observe that I am not authorised to speak of medicine by my previous studies, and he illustrated his meaning by the following observations, which I ask leave of the Academy to reproduce:

"And it is when medical science is placed on such solid foundations that M. Pasteur expects to upset everything by a few laboratory experiments! I have nothing to say about the cultivation of germs; I am willing to accept everything—declaring, however, that I am not competent to speak about what happens in retorts.† But when M. Pasteur drops the part of the skilful experimenter, and undertakes to make applications to medicine, I beg leave to differ from him. For instance, in his recent communication on chicken cholera, in which the discovery of a new germ has opened such vast prospects to his mind, I find that he draws conclusions that are not in accordance with his premises. How can he prove that these infinitely small organisms are the true cause of chicken cholera? Could it not be maintained with equal probability that they are the results of the disease. We have been told that chickens inoculated with the liquid of cultivation had died of chicken cholera, but our eminent colleague has forgotten to prove it. Only one fact is beyond doubt; it

* From *Moniteur Scientifique Quesneville* for July, 1880, p. 782. By P. Casamajor.

† Can Dr. Depaul speak more knowingly of what happens in the human body?—*Trans.*

is that the chickens have died; as to the symptoms, I do not find that they are the same as those of the spontaneous disease. They have died poisoned. This is about all that can be said, if we wish to avoid entering the domain of hypotheses and of preconceived ideas."

That I am ignorant of medical and veterinary matters I admit, for I have often avowed it in this very place. I repeat this confession before you now, but I will say that when an accusation of this nature is made by members of this Academy it becomes a very grave matter, for it means that I speak of things of which I am ignorant, and that I am meddling with medical science without authority. In these conditions my pride as a conscientious investigator rebels against such imputations, and here is my answer:

I owe to myself this justice to say that I never rose among you to speak but it was to enlighten you. The humblest of schoolboys is a master before a scientific assembly when he brings new facts and new ideas. I also owe it to myself to say that I have never intruded on the domain of medicine without extending its boundaries.

As to the question that I have raised, I maintain that I am in the right, that there ought to be controversies on the relations of variola to vaccine, and that what I have observed in chicken cholera leads to the inquiry, whether variola virus can be converted into vaccine virus without passing through the body of animals. Have I not here before me partisans of the dependence, as well as of the independence, of the two viruses. I am waiting for proofs of my being mistaken when I assert that in medical science there are now on this subject two contradictory opinions. I await these, and I wish to discuss this subject to show you that I am far from having spoken on a subject of which I was ignorant, and the blame is with yourselves, who, having no knowledge of it and not understanding it fully, have been led to accuse me of incompetence.

I now come to the example of M. Depaul, to chicken cholera, to the *cultivation of germs in retorts*, according to the expression of M. Depaul. I wish to ask whether I have really *forgotten to prove* that the microscopical germ of chicken cholera is the only cause of disease and death. Here is a vessel containing chicken broth in a state of purity, by which I mean that it will remain in its present condition, without any change, if placed in contact with air perfectly free from any germ of fermentation. The limpidity of the liquid is perfect. On the other hand, we have here two vessels containing turbid liquid. They both contain cultivations of the germ of chicken cholera. This one, at 1 o'clock yesterday afternoon, was in the same state of limpidity as the liquid in the first vessel which I have shown you. To bring the liquid to its present condition I have used this small flask, containing a minute quantity of a liquid of a previous cultivation, and a glass rod drawn to a very fine point. This rod is not hollow, and the only portion of liquid which the fine point can take up is what adheres to its surface. I have transferred this quantity to the clear liquid, and the microscopic organism, although introduced in such infinitely small quanitity, has multiplied so rapidly that a few hours afterwards silky waves could be seen in the liquid, formed by clouds of germs; and, after 24 hours, the turbidity is as you see it. This liquid, which yesterday was nothing but nutritious chicken broth, so perfectly inoffensive that you could inject 1, 2, 10, 20 cubic centimetres under the skin of a chicken without causing either disease or death, is, at this moment, so virulent that if you inject the smallest fraction of a drop under the skin, the chicken will die; its own body will become virulent after local disorders, exhibits of which I place here before you that you may judge of their truly extraordinary and frightful nature.

Do you want now the proof that in this liquid only the solid and animated portion can give rise to the disease? The proof is this:

Filter this liquid by means of this apparatus, which will retain even the smallest of these germs, and inject this filtered liquid under the skin, in quantities equal to tens of cubic centimetres, and no more harm will result than from the injection of the broth before any propagation of germ had taken place in it.

M. Depaul, are you satisfied?

Perhaps not yet. This filtration probably disturbs you. This is too much chemistry, too much *retorts*, as you express it. Then take this tube, full of germs, suspend it for a few days in a place where the temperature is constant, and the germs will fall to the bottom. If we inoculate two chickens, one with the clear liquid at the top, and the other with the liquid of the lower stratum, the first chicken will remain in good health, and the second will die.

You may talk of poison, if you choose; you may make any hypothesis, if you like. I know no more than you do or than anybody does of the mechanism of death following disease—not more than we know of the mechanism of life. You may say that the chicken dies from the effect of poison, but you will be constrained to admit that it is the microscopical organism which gives rise to the poison.

If you are not satisfied with these arguments and proofs of a chemist, I will express the liveliest regret to find that I am not in harmony with one of the most distinguished members of this Academy.

At the conclusion of this paper Dr. Guérin took occasion to say that, for his part, he was not convinced, to which M. Pasteur retorted: "So much the worse for you," and Dr. Guérin said in effect that it was so much the worse for M. Pasteur.

At the meeting of June the 8th, Dr. Guérin engaged to utterly disprove the theories of M. Pasteur at some future meeting.

ON THE

MOLECULAR HEAT AND VOLUME OF THE RARE EARTHS AND THEIR SULPHATES.*

By L. F. NILSON and OTTO PETTERSSON.

At the request of the Royal Academy of Sciences at Stockholm, we some years ago undertook an extended research into the physical properties of the rare earth-metals and their compounds. Having performed the laborious task of separating and purifying their oxides, we are now able to publish our first series of determinations concerning their principal properties, which chemically are of the greatest importance, viz., molecular heat and molecular volume.

The rare earths, with a few exceptions (CeO_2, ThO_2, ZrO_2), belong to a group of sesquioxides. In order to obtain a larger number for comparison we have extended our research not only to the rare earths, but also to some other nearly related compounds, the molecular heat and volume of which were hitherto unknown. As to these values, previously known for some other oxides, Al_2O_3, Fe_2O_3, Cr_2O_3, according to Regnault, Kopp, and others, we have already observed in our preceding paper "On the Essential Properties and Chemical Character of Beryllium" that only such determinations are strictly comparable which are made by the same method, under the same circumstances, and referred to the same unit of measure.

The specific densities and molecular volumes, which are given in the following tables, are obtained by means of a method specially adapted to prevent the errors arising from adhesion of air to pulverulent substances.† The densities taken by this method will therefore generally be found a little higher and the molecular volumes a little lower than the numbers usually given by others.

* A Paper read before the Royal Society, Nov. 18, 1880.

† For the details see Otto Pettersson, "Molecularvolumina einiger Reihen von isomorphen Salzen," in "Nov. Act. reg. Soc. Scient. Ups.," ser. iii. Upsala, 1873.

The specific heats of the different compounds are determined with Bunsen's ice-calorimeter, by means of the same process which we have more fully described in our detailed memoir on beryllium.* All the numbers given are the means of at least two determinations, which agree perfectly, the experiments being made under the most favourable circumstances. As to the values obtained we beg to observe that the specific and molecular heat will be found a little smaller by the ice-melting method than by other methods, on account of the different unit of comparison.

The molecular weight of the different oxides was determined by a special analysis or synthesis of the sulphates, and the very same chemically pure substances were employed both for the thermic, volumetric, and magnetic experiments. The results only and not the details of these experiments are given in the tables.

Oxides.

	Molecular Weight.	Specific Weight.	Specific Heat.	Molecular Heat.	Molecular Volume.
Beryllium oxide—					
Be_2O_3	75·3	3·016	0·2471	18·61	24·97
Aluminium oxide—					
Al_2O_3	102·8	3·990	0·1827	18·78	25·76
Sapphire cryst.—					
Al_2O_3	102·8	3·990	0·1879	19·32	25·76
Chrysoberyl cryst.—					
$Al\frac{2}{3}$ $Be\frac{1}{3}$ O_3	95·9	3·734	0·2004	19·22	25·69
Scandium oxide†—					
Sc_2O_3	136·0	3·864	0·1530	20·81	35·19
Gallium oxide‡—					
Ga_2O_3	184·0	—	0·1060	19·50	—
Yttrium oxide—					
Y_2O_3	227·0	5·046	0·1026	23·29	44·99
Indium oxide—					
In_2O_3	274·8	7·179	0·0807	22·17	38·28
Erbium oxide§—					
Er_2O_3	380·0	8·640	0·0650	24·70	43·98
Ytterbium oxide—					
Yb_2O_3	394·0	9·175	0·0646	25·45	42·94
Lanthanum oxide—					
La_2O_3	326·0	6·480	0·0749	24·42	50·31
Didymium oxide—					
Di_2O_3	341·0	6·950	0·0810	27·62	49·07
Zirconium oxide—					
ZrO_2	122·0	5·850	0·1076	13·13	20·86
Cerium bioxide—					
CeO_2	171·5	6·739	0·0877	15·04	25·45
Thorium oxide—					
ThO_2	264·0	9·861	0·0548	14·47	26·77

Hitherto it was supposed to be a general rule, that the atomic heat of oxygen in any oxide was not less than 3·5 or greater than 5·1. The numbers above given compel us, however, to assign a still lower value to the atomic heat of oxygen in alumina and beryllia, viz., 2·34.‖ Into these oxides it enters with a minimum capacity of heat and volume. From these earths upwards the molecular heat and volume of the sesquioxides gradually increase with increasing molecular weights.

The following table shows that the molecular heat (1) of Er_2O_3, Yb_2O_3, La_2O_3, and Di_2O_3 nearly agrees with those for other sesquioxides, determined by Regnault; (2) that of Be_2O_3 approaches to the same for alumina; and (3) of that ZrO_2, CeO_2, and ThO_2 is as high as the values for SnO_2, TiO_2, and zircon, determined by the same author, and for MnO_2 according to Kopp. The validity of Neumann's law receives hereby a new confirmation.

Formula.	Molecular Weight.	Specific Heat.	Molecular Heat.	Authority.
Bo_2O_3	69·8	0·2374	16·57	Regnault.
Cr_2O_3	152·4	0·1796	27·37	,,
Fe_2O_3	160·0	0·1681	26·90	,,
As_2O_3	198·0	0·1279	25·32	,,
Sb_2O_3	292·0	0·0901	26·31	,,
Bi_2O_3	468·0	0·0605	28·31	,,
TiO_2	82·0	0·1703	13·97	,,
$Si\frac{1}{3}$ $Zr\frac{1}{3}$ O_2 ..	90·8	0·1456	13·22	,,
SnO_2	150·0	0·0933	14·00	,,
MnO_2	87·0	0·1590	13·83	H. Kopp.

Anhydrous Sulphates.

	Molecular Weight.	Specific Weight.	Specific Heat.	Molecular Heat.	Molecular Volume.
Beryllium sulphate—					
$Be_2 3SO_4$	315·3	2·443	0·1978	62·37	129·07
Aluminium sulphate—					
$Al_2 3SO_4$	342·8	2·710	0·1855	63·59	126·50
Scandium sulphate—					
$Sc_2 3SO_4$	376·0	2·579	0·1639	62·42	145·80
Chromium sulphate—					
$Cr_2 3SO_4$	392·4	3·012	0·1718	67·41	130·27
Ferric sulphate—					
$Fe_2 3SO_4$	400·0	3·097	0·1656	66·24	129·16
Gallium sulphate—					
$Ga_2 3SO_4$	424·0	—	0·1460	61·90	—
Yttrium sulphate—					
$Y_2 3SO_4$	467·0	2·612	0·1319	61·60	178·80
Indium sulphate—					
$In_2 3SO_4$	514·8	3·438	0·1290	66·41	149·77
Lanthanum sulphate—					
$La_2 3SO_4$	566·0	3·600	0·1182	66·90	157·22
Cerium sulphate—					
$Ce_2 3SO_4$	567·0	3·912	0·1168	66·23	144·94
Didymium sulphate—					
$Di_2 3SO_4$	581·0	3·735	0·1187	68·96	155·55
Erbium sulphate—					
$Er_2 3SO_4$	620·0	3·678	0·1040	64·48	168·57
Ytterbium sulphate—					
$Yb_2 3SO_3$	634·0	3·793	0·1039	65·87	167·15
Thorium sulphate—					
$Th_2 2SO_4$	424·0	—	0·0972	41·21	—

The molecular heat of the anhydrous sulphates of the sesquioxides varies only within very narrow limits; 61·60

Hydrated Sulphates.

	Molecular Weight.	Specific Weight.	Specific Heat.	Molecular Heat.	Molecular Volume.
Beryllium sulphate—					
$Be_2 3SO_4.12H_2O$	531·3	1·713	—	—	310·17
Yttrium sulphate—					
$Y_2 3SO_4.8H_2O$	611·0	2·540	0·2257	137·91	240·55
Lanthanum sulphate—					
$La_2 3SO_4.9H_2O$	728·0	2·853	0·2083	151 64	255·17
Cerium sulphate—					
$Ce_2 3SO_4.5H_2O$	657·0	3·220	0·1999	131·33	204·04
Didymium sulphate—					
$Di_2 3SO_4.8H_2O$	725·0	2·878	0·1948	141·23	251·91
Erbium sulphate*—					
$Er_2 3SO_4.8H_2O$	764·0	3·180	0·1808	138·13	240·25
Ytterbium sulphate†—					
$Yb_2 3SO_4.8H_2O$	778·0	3·286	0·1788	139·11	236·79

* According to Cleve.
† According to Nilson.

* *Pogg. Ann.* [2], iv., p. 554.
† According to Nilson.
‡ For the oxide employed we are under obligation to M. Lecoq. de Boisbaudran, who placed 0·138 grm. gallium at our disposal.
§ Prof. Cleve has kindly placed at our disposal the purest erbia he has been able to obtain.
‖ See the preceding paper.

to 68·96 for yttrium and didymium sulphate. The values for the salts of chromium, iron, indium, lanthanum, cerium, and didymium are nearly identical; whilst even the values of the remainder approach each other very nearly.

As the hydrated sulphates (see preceding page) are decomposed when heated to 100°, their capacity of heat was determined between 0° and 46° in the vapour of boiling CS_2; the beryllium sulphate not bearing even that temperature without losing water, its molecular heat could not be ascertained.

On subtracting the values obtained for the anhydrous salts from the same numbers of the hydrated sulphates, we obtain a remainder expressing the molecular heat and volume of the water in combination. Thus the following values are obtained:—

Compounds.	Water in Combination.	Molecular Heat.	Molecular Volume.
Ytterbium sulphate ..	$8H_2O$	9·15	8·70
Erbium sulphate	$8H_2O$	9·21	8·96
Yttrium sulphate	$8H_2O$	9·54	7·72
Didymium sulphate..	$8H_2O$	9·03	12·04
Lanthanum sulphate.	$9H_2O$	9·42	10·88
Cerium sulphate	$5H_2O$	13·02	11·82

The molecular heat and volume of free water being = 18, it will be seen that by entering into combination with the sulphates of the rare earth-metals its heat and volume are reduced in an extraordinary degree. In fact, the molecular heat and volume of water in these salts descends to a minimum value hitherto unknown.

Comparing the values given above, we readily find that in those groups of compounds intimately connected by isomorphism the molecular heat of the compounds increases and the molecular volume decreases with increasing molecular weight of the compound or atomic weight of the element. This will be shown by the following table, in which the different isomorphous compounds, partly of yttrium, erbium, and ytterbium, partly of lanthamum and didymium, are brought into comparison:—

Elements.	Atomic Weight.	Oxides		Anhydrous sulphates.		Hydrated sulphates.	
		Molecular heat.	Molecular volume.	Molecular heat.	Molecular volume.	Molecular heat.	Molecular volume.
Yttrium	89·5	23·29	44·99	61·60	178·80	137·91	240·55
Erbium.....	166·0	24·70	43·98	64·48	168·57	138·13	240·25
Ytterbium ..	173·0	25·45	42·94	65·87	167·15	139·11	236·79
Lanthanum..	139·0	24·42	50·31	66·90	157·22	—	—
Didymium ..	146·5	27·62	49·07	68·96	155·55	—	—

Especially with regard to beryllia and the question of its real composition, the values given above are of the greatest importance. In respect of this we observe that: 1st, the atomic heat of oxygen in beryllia is identical with that in alumina and nearly identical with the same value in other closely related oxides, if beryllia = Be_2O_3 (see our preceding paper); 2nd, under the same supposition the molecular heat and volume of beryllia and alumina are nearly identical, whether the latter earth be examined in the state of crystallised sapphire or of an amorphous powder, and, further, if we consider chrysoberyl not as an aluminate, but as $\left.\begin{matrix}Al_2\\Be\end{matrix}\right\}O_3$, this mineral has yielded identical values; 3rd, the molecular heat and value of beryllium sulphate, compared with the same values for the other nearly allied sulphates of aluminium, scandium, gallium, and yttrium, support the formula, Be_2O_3 which we have given.

Taking into consideration the above-mentioned circumstances, and those related in our former papers, with the fact that the atomic heat and volume of metallic beryllium, as well as the molecular heat and volume of beryllia and its sulphate, would assume values quite exceptional, if the formula for the oxide were BeO, we think, therefore, the question of the valence of beryllium may be considered as finally decided. In fact, there is no physical property of beryllium, beryllia, or its sulphates, which does not testify to our view being the correct one, and from a chemical point of view the same holds good. It is, we think, unnecessary to take space up here with a repetition of the various reasons which support this conclusion. We refer, therefore, to our detailed paper on beryllium, above quoted, and only mention here that this metal belongs on account of its sulphate,

$$3K_2SO_4+Be_23SO_4,$$

to the series of the gadolinite and cerite metals, this salt having a composition typical for all the members of this series (Be, Sc, Y, La, Ce, Di, Tr, Y_α, Y_β, x, Er, Tm, Yb). The series of these elements, the leading member of which beryllium unquestionably is, stands certainly in the nearest proximity with another series, that of aluminium (Al_2, Ga_2, Tn_2, Cr_2, Mn_2, Fe_2), but this nevertheless decidedly differs from the former by another typical double sulphate,

$$K_2SO_4+R_23SO_4+24H_2O.$$

or alum.

The fact, which has been alleged as a proof of the bivalence of beryllium, namely that the chloride fuses and sublimes at a higher temperature than aluminium chloride is of no importance, for it will be found that amongst the members of the former series, with its difficultly fusible and volatilisable chlorides, many analogies exist for beryllium, not only in this, but in many other respects.

Lastly, we subjoin a table showing the magnetic properties of the rare earths. Mr. Knut Angström kindly undertook this research, employing a powerful electromagnet of Ruhmkorff, between the poles of which the oxides showed the following properties:—

Magnetic.	Diamagnetic.
Cr_2O_3	Be_2O_3
Fe_2O_3	Al_2O_3
Y_2O_3	Sc_2O_3?
Di_2O_3	In_2O_3
Er_2O_3	La_2O_3
Yb_2O_3	—
—	ZrO_2
CeO_2	ThO_2

PRELIMINARY NOTE ON THE EXISTENCE OF ICE AND OTHER BODIES IN THE SOLID STATE AT TEMPERATURES FAR ABOVE THEIR ORDINARY MELTING-POINTS.*

By THOMAS CARNELLEY, D.Sc.,
Professor of Chemistry in Firth College, Sheffield.

In the present communication I have the honour to lay before the Royal Society a detailed description of experiments, proving that under certain conditions it is possible for ice and other bodies to exist in the solid state at temperatures far above their ordinary melting-points. On a future occasion I hope to submit to the Society a full account of the investigation of which these experiments form a part, together with the conclusions to be drawn therefrom. The bodies whose behaviour I propose to discuss at present are ice and mercuric chloride.

Ice.

In the case of ice the great difficulty to be overcome is to maintain the pressure in the containing vessel below 4·6 millims., *i.e.*, the tension of aqueous vapour at the freezing-point, for it will be easily understood that if the ice be but slightly heated the quantity of vapour given off would soon be sufficient to raise the pressure above that point. After several fruitless attempts the following plan, involving the principle of the cryophorus, was adopted.

* A paper read before the Royal Society, January 6, 1881.

A strong glass bottle, such as is used for freezing water by means of Carré's pump, was fitted with a cork and glass tube, and the cork well fastened down by copper wire and paraffin wax. The tube and bottle were then filled with mercury, and the bottle connected with the end of the tube by means of the piece of stout india-rubber pump tubing, a thermometer having been previously attached by a wire to the lip of the tube. The connection was made tight by fine copper wire and wax. The tube was about 1 inch in diameter, and about 4 feet long from the bend; after connection with the bottle it was completely filled with mercury, care being taken to expel the air as completely as possible; the whole was then inverted over the mercurial trough, when the mercury fell to 0, the ordinary height of the barometer. The mercury was run out by tilting up the bottle and inclining the tube. By this means a Torricellian vacuum was obtained in the flask and upper part of the tube. The tube was next brought to the vertical, and the bottle placed in a trough. A tin bottle without a bottom was fitted with a cork, so that it might slide somewhat stiffly along the vertical tube.

To begin with, the tin bottle was placed in position and filled with a freezing mixture of salt and ice. Some boiled water was then passed up the tube, sufficient to form a column about 2 inches deep. The thermometer had been previously arranged, so that its bulb might be one or two inches above the surface of the water. The bottle was next surrounded by a good quantity of a freezing mixture of salt and ice, in order that any vapour given off from the water in the tube might be condensed in the bottle as fast as it was formed, and thus the internal pressure might never be more than about 1·0 to 1·5 millims. When the bottle had been sufficiently cooled, which required about fifteen minutes, the tin vessel was slid down the tube and its freezing mixture removed. The water had then solidified to a mass of ice, which on heating with the flame of a Bunsen's burner melted either wholly or partially, and the liquid formed began at once to boil. The fusion commenced first at the bottom of the column of ice, whereas the upper part fused only with difficulty, and required rather a strong heat. The fusion in this case was probably due to the steam evolved from the lower portions of the ice column being imprisoned and unable to escape, and hence producing pressure sufficient to cause fusion.

When the greater part of the ice had been melted the tube was tightly clasped by the hand, the heat of which was sufficient to produce a somewhat violent ebullition. The liquid in boiling splashed up the side of the tube and on to the bulb of the thermometer, where it froze into a solid mass. By this means the ice was obtained in moderately thin layers. The tube at the points indicated by the arrows was then strongly heated by the flame of a Bunsen's burner, with the following results:—

The ice attached to the sides of the tube at first slightly fused, because the steam evolved from the surface of the ice next the glass being imprisoned between the latter and the overlying strata of ice could not escape, and hence produced pressure sufficient to cause fusion; but as soon as a vent-hole had been made fusion ceased, and the whole remained in the solid state, and neither the ice on the sides of the tube nor that on the bulb of the thermometer could be melted, however great the heat applied, the ice merely volatilising without previous melting. The thermometer rose to temperatures varying between 120° to 180° in different experiments, when the ice had either wholly volatilised or had become detached from the bulb of the thermometer. The ice attached to the latter did not partially fuse at the commencement of the heating, because, the heat reaching the outer surface of the ice first, evaporation could take place from a free surface and the vapour not become imprisoned, as was the case with the ice attached to the sides of the tube.

These experiments were repeated many times and always with the same result, except in one case in which the heat applied had been very strong indeed and the ice attached to the sides of the tube fused completely. On removing the lamp, however, for a few seconds the water froze again, notwithstanding that the portion of the glass in contact with it was so hot that it could not be touched without burning the hand.

The chief conditions necessary for success appear to be —(1) That the condenser is sufficiently large to *maintain* a good vacuum: in the present case the capacity was about three-quarters of a litre. (2) That the ice is not in too great mass, but arranged in thin layers. Further, in the case where the heat is applied to the under surface of the layers of ice, the latter must be sufficiently thin to allow of a vent-hole being formed for the escape of the steam coming from below, otherwise fusion occurs. When the heat is applied to the free surface of the ice the layers may be much thicker.

Mercuric Chloride,

m.p. = 288°, re-solidifies at 270° to 275°, b.p. = 303°.

About 40 grs. of pure mercuric chloride were place in a tube, and a thermometer arranged with its bulb imbedded in the salt. The drawn-out end of the tube was connected by stout india-rubber tubing with one branch of a three-wayed tube, whilst the other was attached to the manometer. The remaining branch was connected with a Sprengel pump, fitted with an arrangement for regulating the pressure.

When the pressure had been reduced by means of the pump to below 420 millims., the mercuric chloride was strongly heated by the flame of a Bunsen's burner, with the following results:—

Not the slightest fusion occurred, but the salt rapidly sublimed into the cooler parts of the tube, whilst the unvolatilised portion of the salt shrank away from the sides of the tube and clung tenaciously in the form of a solid mass to the bulb of the thermometer, which rose considerably above 300° C., the mercury of the thermometer shooting up to the top of the stem. After slight cooling the air was let in, and under the increased pressure thus produced the salt attached to the bulb of the thermometer at once melted and began to boil, cracking the tube at the same time.

The experiment was next varied as follows:—

About the same quantity of chloride was placed in the tube as before, and heated by the full flame of a Bunsen's burner. The lamp was applied during the whole of this experiment, and the size of the flame kept constant throughout. The mercuric chloride first liquefied and then boiled at 303° under ordinary pressure, and whilst the salt was still boiling the pressure was gradually reduced to 420 millims., when the boiling-point slowly fell to 275°, at which point the mercuric chloride suddenly began to solidify, and at 270° was completely solid, the pressure then being 376 millims. When solidification was complete the pump was stopped working, but the heat still continued to the same extent as before. The salt then rose rapidly to temperatures above that at which a thermometer could be used, but not the least sign of fusion was observed. From the completion of the solidification to the end of the experiment the pressure remained at about 350 millims.

The above experiment, which was repeated three times, shows, therefore, that when the pressure is gradually reduced from the ordinary pressure of the atmosphere to 420 millims., and the boiling-point simultaneously from 303° to 275°, the salt solidifies while it is still boiling and in contact with its own hot liquid, notwithstanding that it is being strongly heated at the same time; and that, after solidification is complete at 270°, the temperature then rises far above the ordinary boiling-point (303°) of the substance without producing any signs of fusion. Under ordinary circumstances, mercuric chloride melts at 288° and re-solidifies at 270° to 275°, *i.e.*, at a temperature identical with that at which it solidifies under diminished pressure, as above described.

The solid mercuric chloride obtained on solidification under the combined influence of diminished pressure and

the application of a strong heat had a peculiar appearance, quite different to that produced when the substance is allowed to solidify in the ordinary way. It appeared to consist of a mass of pearly leaflets closely packed together round the bulb of the thermometer.

Any final explanation of these phenomena is reserved until further experiments have been made.

Appendix.

Since writing the foregoing, it has been said in explanation of the phenomena therein described, that the thermometer, though embedded in the mass of ice, did not really indicate the true temperature of the letter. With the object, therefore, of proving whether the ice is hot or not, I have, at the suggestion of Professor Roscoe, made the following calorimetrical determination :—

The arrangement of the apparatus was so modified that the ice, after being strongly heated, could be suddenly dropped into a calorimeter containing a known quantity of water of known temperature. The resulting temperature, after the ice had been dropped in, was read off by a thermometer graduated so as to indicate a difference of 0·05°C. The weight of the ice was found by re-weighing the calorimeter.

So far I have only had the opportunity of completing the two following determinations, and in the second of these the weight of the ice could not be found, as a small quantity of water was lost out of the calorimeter, owing to a sudden jerk at the moment the ice entered it :—

(1.) Weight of water in calorimeter, including the value of the latter = 185 grms.
Weight of ice dropped in = 1·3 grms.
Temperature of calorimeter before = 13·4°
" " after = 13·6°

Rise in temperature = 0·2°

$M(\theta - t) + 80W = W(T - \theta)$

$(185 \times 0{\cdot}2) + (80 \times 1{\cdot}3) = 1{\cdot}3(T - 13{\cdot}6)$

$\therefore T = 122°$ C. Where T = temperature of ice.

(2.) Weight of water in calorimeter, &c. = 185 grms.
Temperature of calorimeter before = 12·7°
after = 12·8°

Rise in temperature = 0·1°

On weighing the calorimeter after the experiment, the increase in weight was only 0·15 grm., but as a portion of the water had been jerked out during the operation the true weight of the ice, and therefore its temperature, could not be found. But since the calorimeter had slightly risen in temperature, the ice must have been above 80° C.

From the nature of the experiment, as carried out on the present scale, the weight of the ice which can be dropped into the calorimeter is only small, and therefore the rise in temperature is but slight. But since a fall in temperature of a much larger amount ought to have been obtained had the ice been at 0°, it is considered that the above experiments are conclusive. Great care was taken in order to obtain correct temperatures in the calorimeter. The latter was inclosed in several casings, and the water was allowed to stand in it for several hours before the experiment, so that it might first attain the temperature of the room, whilst the time which elapsed between the readings of the thermometer before and after the ice was dropped in would not be more than from ten to fifteen seconds.

In the course of the next few weeks I intend to make one or two more determinations, and, if possible, on a larger scale.

Dependence of the Diffusion-Coefficient of Gases upon Temperature.—A. von Obermayer.—The author gives a table showing the absolute value of the diffusion-coefficients of five gases at 0°, and at the normal atmospheric pressure.—*Weiner Anzeiger*, 1880, 94-95.

ON THE

DETECTION AND DETERMINATION OF ARSENIC IN ORGANIC MATTER.*

By R. H. CHITTENDEN and H. H. DONALDSON.

THERE have been many different methods devised for the detection and determination of arsenic in organic matter, but few are entirely free from objectionable features, or sufficiently accurate to insure perfect reliance upon results obtained by their use. At the present day the toxicologist is expected to answer questions as to rapidity of absorption and rate of elimination, and is required to follow the track of the poison step by step in its course through the body. He has need of methods which will allow of its detection with certainty even though present in very minute quantity. And when by chemical evidence alone the toxicologist is required to state whether the poison has been introduced into the body long before death, or, in other words, whether it is a case of acute or chronic poisoning, none but the most accurate method will suffice to give the information needed. Recently Gautier,† recognising the need for physiological purposes of a more trustworthy method for the determination of arsenic in animal tissue, has described a new process which has in it many commendable features, but which requires reagents certainly not always obtainable in a state of purity or from arsenic, though a smaller number is needed than in the commonly used method of Fresenius and Babo.

That a method which requires ten or twelve different chemicals for its completion in the detection of arsenic is a dangerous one, especially in medico-legal cases, no conscientious worker can deny; and a method which involves the use of hydrogen sulphide for 12 to 24 hours will no doubt be gladly dispensed with by those toxicologists who have vainly spent days in the preparation of pure chemicals for the generation of this gas. The method which we have to propose has been suggested by the use of Gautier's process, and some portions of our method may be considered simply as modifications of his, while the method as a whole has to recommend it the following features: extreme accuracy, great delicacy, and the use of but three chemicals—nitric acid, sulphuric acid, and zinc.

I. *Method for the Complete Extraction of Arsenic from Organic Matter.*

Gautier's method of destroying the organic matter is based upon the older methods of Orfila‡ and Filhol,§ consisting of successive oxidations with nitric and sulphuric acids at elevated temperatures. The first part of our process is practically the same, except that we use a much lower temperature.

100 grms. of the suspected material, cut into small pieces, are placed in a porcelain casserole of 600 c.c. capacity and provided with a stirring rod of stout glass. 23 c.c. of pure concentrated nitric acid are added, and the dish placed on a small air-bath‖ provided with a thermometer and a single Bunsen burner. The mixture is now heated at 150° to 160° C., with occasional stirring. At first the tissue takes on a yellowish colour, then swells up somewhat, becoming finally quite thick; soon changes again, becoming liquid, and then generally requires heating from 1½ to 2 hours, the temperature sometimes being raised to 180° C.

At this point the mass, being now quite thick again, usually takes on a deeper yellow colour or orange shade. When this change of colour is noticed the casserole is

* Contributions from the Sheffied Laboratory of Yale College.—*American Chemical Journal*, vol ii., No. 4.

† *Bulletin de la Société Chimique*, 24, 250.

‡ "Traité de Toxicologie", 1, 494. Paris, 1852.

§ "Thesis." Paris, 1848.

‖ For air-bath we use an ordinary flat-bottomed tin basin, 7 inches in diameter, 3 inches deep, with a cover provided with an opening 5 inches in diameter. This bath is set in an iron ring fastened to a stout lamp-stand, while the end of the thermometer passes through a small hole near the edge of the cover a short distance into the bath, so that the temperature can be regulated.

taken from the bath and 3 c.c. of pure concentrated sulphuric acid added and the mixture stirred vigorously. The addition of concentrated sulphuric acid to the viscid residue rich in nitric acid and nitro-compounds naturally gives rise, especially at this temperature, to a considerable commotion: the mass becomes brown, swells up, nitrous fumes are copiously evolved, immediately followed by dense white fumes of suffocating odour, while the residue in the dish is changed either into a dry carbonaceous mass or a black, sticky, tar-like mass. Although the oxidation is so powerful, no deflagration takes place, and the carbonisation is effected in this manner without the volatilisation of any arsenic. The casserole is again placed on the bath and heated for a few minutes at 180° C., then, while still on the bath, 8 c.c. of pure concentrated nitric acid are added drop by drop with continual stirring, the object being, as Gautier says, to destroy more completely the organic matter, and at the same time the nitric acid falling drop by drop on the carbonaceous residue tends to prevent the formation of sulphurous acid and the consequent formation of insoluble arsenious sulphide.

After the addition of the nitric acid the dish is heated at 200° C. for fifteen minutes, and when cold a hard carbonaceous residue is the result, entirely free from nitric acid. In working with different kinds of tissue, slight deviations from the above description will frequently be observed. When much bony matter is present the last residue takes on a somewhat different character, owing to the presence of calcium sulphate, and occasionally when the 3 c.c. of sulphuric acid are added the oxidation does not at once take place, but requires a little longer heating on the air-bath. But when such is the case the mixture needs constant watching in order to remove the dish from the bath at the first approach of the oxidation.

The arsenic now exists as arsenic acid, readily soluble in water. The carbonaceous residue is thoroughly extracted with boiling water, and in order to avoid all loss is not previously pulverised, but the casserole in which the oxidation took place is filled with water and heated on the water-bath for several hours. The hard mass soon softens, and by repeated treatment in this manner readily gives up all its arsenic to the aqueous solution; it is, however, better to have the carbonaceous residue in contact with different portions of warm water for about 24 hours to insure the complete extraction of the arsenic.

The reddish brown fluid containing some organic matter and arsenic acid is now evaporated on the water-bath to dryness, care being taken that the entire residue is finally obtained in one casserole. This residue* of organic matter and arsenic is dissolved in a definite quantity of a dilute sulphuric acid with the aid of gentle heat, and in that form, or, as frequently happens, in the form of a fluid with organic matter in suspension, is introduced into the Marsh apparatus in the manner about to be described, and the arsenic weighed in the metallic state.

The following results show the accuracy of the method:—

Quantity of Arsenic introduced.	Wt. of Metallic Arsenic found.	Theoretical Wt. Metallic Arsenic.
100 grms. beefsteak with—		
0·004 grm. As_2O_3	0·00300	0·00303
0·004 ,, ,,	0·00300	0·00303
0·004 ,, ,,	0·00290	0·00303
0·003 ,, ,,	0·00219	0·00227
0·005 ,, ,,	0·00369	0·00378
0·005 ,, ,,	0·00372	0·00378

* When the residue left by the evaporation of the water is quite large, it is sometimes better to reoxidise it. This is quickly accomplished by adding a few c.c. of concentrated nitric acid to the contents of the casserole and heating on the air-bath at 150 to 180° C. until a reddish solution is obtained. Then 3 to 5 c.c. of concentrated sulphuric acid are added and the mixture heated at the above temperature until the nitric acid is completely driven off. The thin black fluid is then carefully mixed with the requisite quantity of No. 2 acid, shortly to be described, and introduced into the Marsh apparatus. Frequently quite a heavy, flocculent precipitate separates from the sulphuric acid solution. This does not interfere, but is poured, together with the fluid, directly into the receiving bulb, which is purposely provided with a delivery tube of large calibre.

Thus, from the evidence here afforded, we have a method for the determination of arsenic which is extremely accurate, and, above all other things, a method which requires but three chemicals, none of which are extremely difficult to obtain pure, and this for medico-legal purposes is a desideratum long wished for.

II. *On the Marsh Apparatus.*

There is no method for the detection of arsenic which promises better results, either qualitatively or quantitatively, for toxical purposes, than the decomposition of arseniuretted hydrogen by heat. Indeed, no other method allows of the accurate detection of such minute quantities as the method of Marsh if properly conducted. In making use of this method as a test for arsenic in the usual manner no particular precautions have been taken to have all of the arsenic deposited in the heated tube, and in the qualitative tests for which this method has hitherto been generally used it is well known that the gas is only partially decomposed, and thus it has come to be the general impression that arseniuretted hydrogen is only partially decomposed by heat. The explanation of many poor results which have been obtained by decomposing arseniuretted hydrogen, formed from a known quantity of arsenious oxide, by heat and weighing the metallic arsenic, is not at all difficult. Otto* in describing some experiments on this point states that with 10 milligrms. of arsenious oxide he sustained a loss of 0·8 milligrm. the tube being heated by two lamps and the length of the experiment 1½ hours, while the arsenic was introduced in quantities of 1 milligrm.; but in those experiments in which the arsenic was introduced more rapidly and the time of the experiment shortened, the results were very much poorer.

Dr. Draper† in describing a new method for the determination of arsenic based on the decomposition of arseniuretted hydrogen by heat, proved experimentally that a rapid current of arseniuretted hydrogen passed through a tube heated at five different points by single Bunsen burners was not entirely decomposed, as was evinced by the presence of five distinct mirrors; but when the evolution of gas was very slow, the arsenic was nearly all stopped by the first burner. Thus the cause of the whole trouble, which is almost entirely a mechanical one, lies in the too rapid and irregular evolution of gas, the too rapid and irregular addition of the arsenical mixture, and insufficient length of heated tube.

Gautier‡ in his recently described process for determining arsenic by the decomposition of arseniuretted hydrogen, has devised an improved arrangement for controlling the evolution of gas, by slowly introducing the arsenic mixed with a definite quantity of dilute sulphuric acid of known strength, later adding the same quantity of a stronger acid, and lastly a still stronger acid; the increasing strength of acid added counteracting the diluting effect of the reaction, so that the strength of acid remains about the same during the entire process of 2½ to 3 hours in the determination of 0·005 grm. of arsenious oxide. Gautier decomposes the gas by passing it through a tube heated with red coals for a distance of 20 to 25 centimetres.

In making use of the Marsh apparatus according to Gautier's plan, we have so modified it at the suggestion of Prof. S. W. Johnson that it now appears to combine all the essentials of a perfect apparatus.

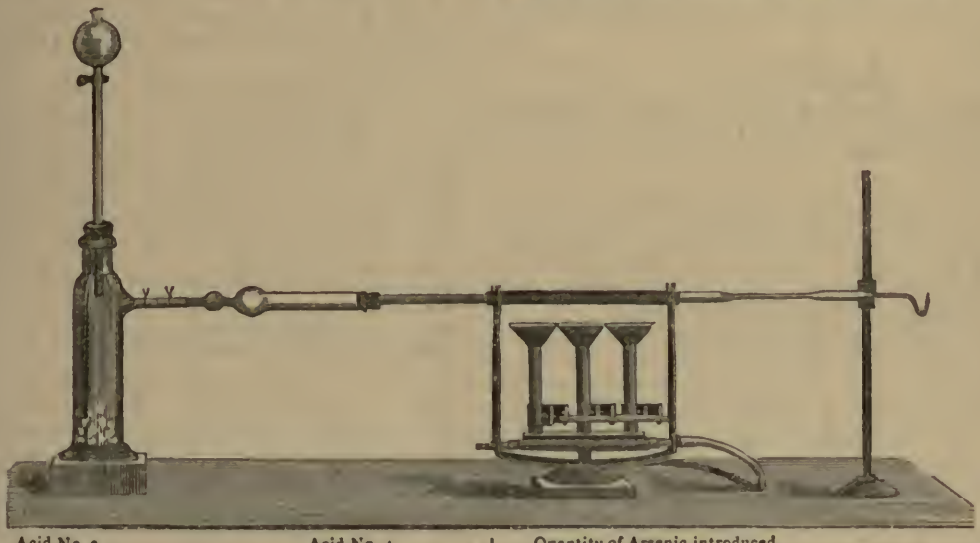
The flask, a Bunsen's wash-bottle of 200 c.c. capacity, is provided with a small separating funnel of 65 c.c. capacity, with glass stop-cock. This is a very material aid to the obtaining of a slow and even evolution of gas, a very important desideratum when all loss is be avoided; for with only a funnel tube, every time a small portion of fluid is added a sudden rush of gas takes place, with probably a small but still more or less appreciable loss. But the separating funnel filled with the acid mixture can be so arranged as to give a constant and regular supply of fluid at the rate of two or three drops per minute, more or less.

* *Anleitung zur Ausmittelung der Gifte*, 1875, 122.
† *American Chemist*, ii., 456.
‡ *Bulletin de la Société Chimique*, xxiv., 258

The gas generated is dried by passing through a calcium chloride tube, and then passes through a tube of hard glass, heated to a red heat by a miniature furnace of three Bunsen lamps with spread burners, so that a continuous flame of six inches is obtained, and with a proper length of cooled tube not a trace of arsenic passes by. The glass tube where heated is wound with a strip of wire gauze, both ends being supported upon the edges of the lamp frame, so that the tube does not sink down when heated. The small furnace is provided with two appropriate side pieces of sheet metal, so that a steady flame is always obtained. When the quantity of arsenic is very small the tube is naturally so placed that the mirror is deposited in the narrow portion, but when the arsenic is present to the extent of 0·005 grm. the tube should be 6 m.m. in inner diameter, and so arranged that fully two inches of this large tube are between the flame and the narrow portion. When the quantity of arsenic is less the tube can naturally be smaller.

The acids of different strengths, and which for convenience we prepare in considerable quantities, are made as follows:

Acid No. 1.	Acid No. 2.
545 c.c. pure conc. H_2SO_4.	109 c.c. pure conc. H_2SO_4.
5000 c.c. H_2O.	1640 c.c. Acid No. 1.



Acid No. 3.	Acid No. 4.
218 cc. pure conc. H_2SO_4.	530 cc. pure conc. H_2SO_4.
1640 cc. Acid No. 1	1248 cc. H_2O.

25—35 grms. of granulated zinc previously alloyed with a small quantity of platinum are placed in the generator, and everything being in position, the apparatus is filled with hydrogen by the use of a small quantity of acid No. 2. After a sufficient time has elapsed the gas is lighted at the jet, and the glass tube heated to a bright redness.

The arsenical solution in concentrated form is mixed with 45 c.c. of acid No. 2, and the mixture passed into the separating funnel, from which it is allowed to flow into the generator at such a rate that the entire fluid is introduced in one hour or one and a half; 40 c.c. of acid No. 3 are then added and allowed to flow slowly into the generator, and lastly 45 c.c. of acid No. 4. The amount of time required will vary with the amount of arsenic: 2—3 milligrms. of arsenic will require about two to three hours for the entire decomposition, while 4—5 milligrms. will need perhaps three to four hours. Where the amount of arsenic is small, only 25 grms. of zinc are needed, and but 45 c.c. of acid No. 2, 30 c.c. of acid No. 3, and 30 c.c. of acid No. 4; but when 4—5 milligrms. of arsenic are present, it is better to take the first mentioned quantities of zinc and acids.

The arsenic being thus collected as a large or small mirror of metal, the tube is cut at a safe distance from the mirror, so that a tube of perhaps 2—6 grms. weight is obtained. This is carefully weighed and then the arsenic removed by simple heating; or, if the arsenic is to be saved as in a toxical case, dissolved out with strong nitric acid. The tube is then cleaned, dried, and again weighed, the difference giving the weight of metallic arsenic, from which, by a simple calculation the amount of arsenious oxide can be obtained. The results are exceedingly satisfactory, as is shown by the following, which were obtained by introducing definite quantities of arsenious oxide in the form of a solution mixed with 45 c.c. of No. 2 acid, &c.

Quantity of Arsenic introduced.		Wt. of Metallic Arsenic found.	Theoretical Wt. of Metallic Arsenic.
0·005 grm.	As_2O_3	0·00373	0·00378
0·005 ,,	,,	0·00370	0·00378
0·004 ,,	,,	0·00300	0·00303
0·002 ,,	,,	0·00151	0·00151

In order to ascertain how delicate the detection of arsenic by this form of apparatus is, the following tests were made, using carefully prepared standard solutions of arsenious oxide and accurately graduated burettes.

Quantity of Arsenic introduced.			
0·0001	grm. As_2O_3	distinct mirror.	
0·00001	,, ,,	,,	,,
0·000001	,, ,,	,,	,,
0·0000001	,, ,,	no mirror visible.	

Thus we have the $\frac{1}{1000}$th of one milligrm. of arsenious oxide as the smallest quantity to be detected by this form of the Marsh apparatus.

Wormley* finds the limit when the amount of fluid is small and the apparatus likewise small, $\frac{1}{10000}$th of one grain of arsenious oxide, which is equal to 0·0000001296 grm. of arsenious oxide. That 0·000001 grm. of arsenious oxide is the limit under any circumstances we have proven by taking 0·0000001 grm. and introducing this quantity into a very small apparatus with strong acid, &c., obtaining a negative result.

III. *Influence of Organic Matter on the Separation of Arsenic as Arseniuretted Hydrogen.*

Dr. T. Boeke, of Holland, in a recent paper on the detection of arsenic in organic mixtures † says—"The admirable method of Marsh in its improved form allows

* "Micro-Chemistry of Poisons," 287.
† Chemical News, vol. xli., p. 177.

the detection of the minutest trace of arsenic, even in the most complicated mixtures, but with one restriction, viz., that the solution to be examined be wholly free from organic matter." This statement expresses the prevalent opinion in regard to the influence of organic matter on the Marsh test; but the following experiments, of which those given are but a few of the many tried, show how erroneous such an opinion is. In conducting these experiments with organic matter, after the zinc is placed in the generator, 15 drops of sweet oil are allowed to flow down the side, and this as the fluid is introduced floats on top and thereby prevents any troublesome frothing. The only other thing to be guarded against is the too rapid introduction of the acids, whereby loss as well as frothing of the mixture may ensue; and, secondly, the heating of the flask by the chemical reaction. If necessary this latter can be prevented by placing the generator in a glass or other dish so that a stream of cold water can continually play about it, which will keep the flask sufficiently cool to prevent the formation of any hydrogen sulphide which might otherwise show itself in slight quantity.

The first experiments were made with urine:—

Quantity of Arsenic introduced.	Wt. of Metallic Arsenic found.	Theoretcl. Wt. of Metallic Arsenic.
0·00475 grm. As_2O_3 in 50 c.c. urine	0·00350	0·00359
0·00470 " " " "	0·00352	0·00356
0·00001 " " " "	distinct mirror	
0·000001 " " " "	" "	
0·00001 " " in 250 c.c. urine concentrated to 50 c.c.	" "	

Thus it becomes very plain that arsenic contained in urine to the extent of 0·000001 grm. can be detected with certainty, its organic matter not offering any appreciable hindrance.

Mayençon and Bergeret* have devised a new method for the detection of minute traces of arsenic, which they have designed especially for ascertaining the rate of elimination of arsenic by the kidneys. They introduce the urine directly into a flask in which hydrogen is being generated, and ascertain the presence of arsenic by testing the gas as it issues from the end of the tube by means of a paper moistened with mercuric chloride solution, a yellow stain on the paper showing the presence of arsenic. The yellow stain is due to the formation of a compound which, according to H. Rose†, contains 1 atom of arsenic, 6 of mercury, and 3 of chlorine. By means of this reaction they were able to obtain a yellow colour in five minutes by introducing one-tenth c.c. of a fluid containing 5 grms. per litre of potassium arsenate. As this amount is equivalent to but 0·000193 grm. of arsenious oxide it cannot be considered extremely delicate, and certainly a method which is dependent entirely on a particular shade of colour as an indicator of the presence of the substance looked for is hardly to be compared with such an exact method as that of Marsh. Tests were now made with organic matter in the form of extractive matter from 100 grms. of tissue. A large number of oxidations of lean beef in portions of 100 grms., made as already described with nitric and sulphuric acids, were extracted with boiling water, and the so-obtained aqueous extract evaporated to a thick residue. To each residue from 100 grms. of beef definite quantities of arsenious oxide were added in solution, then 45 c.c. of acid No. 2, and this mixture introduced into the Marsh apparatus recently described.

The results are given in preceding column.

Thus we have abundant evidence that the organic matter which is present here in considerable quantity does not interfere in the least with the recovery of the entire amount of arsenic. Naturally care must be taken that the stronger acid No. 4 does not flow into the generator too rapidly, as it may thereby produce an uncontrollable frothing; the presence of the oil, however, is sufficient to prevent frothing under proper circumstances.

Quantity of Arsenic introduced.	Wt. of Metallic Arsenic found.	Theoretical Wt. of Metallic Arsenic.
0·001 grm. As_2O_3 in extract from 100 grms. beef ..	0·00070	0·00075
0·001 grm. do. do.	0·00075	0·00075
0·002 grm. do. do.	0·00150	0·00151
0·002 grm. do. do.	0·00150	0·00151
0·003 grm. do. do.	0·00220	0·00227
0·003 grm. do. do.	0·00220	0·00227
0·004 grm. do. do.	0·00290	0·00303
0·004 grm. do. do.	0·00290	0·00303
0·005 grm. do. do.	0·00369	0·00378
0·005 grm. do. do.	0·00369	0·00378
0·005 grm. do. do.	0·00375	0·00378
0·005 grm. do. do.	0·00375	0·00378
0·00001 grm. do. do. ..	distinct mirror	
0·000001 grm. do. do. ..	faint mirror	

* *Comptes Rendus*, 79, 118.

† "Handbook of Chemistry," 4, 267. Leopold Gmelin.

NOTICES OF BOOKS.

Exercises in Practical Chemistry. (Vol. I.) *Elementary Exercises.* By A. G. Vernon Harcourt, F.R.S., Sec. C.S., and H. G. Madan, F.C.S. Third edition; revised by H. G. Madan, F.C.S. (Clarendon Press Series.) Oxford: Clarendon Press. London: H. Frowde.

This work has certain features which appeal strongly to our sympathies. It is written entirely without reference to any examination whatever, and aims at furnishing a course of study for those who are beginning to learn practically. The object of the authors is plainly to teach the arts of experiment and observation, and the equally important process of drawing right conclusions from the phenomena witnessed. Chemistry studied in this manner is not a mere heap of names and figures and symbols overburdening the memory, but a valuable course of discipline for all whom it concerns to draw just inferences from facts rightly observed—a discipline which the physical sciences only are able to afford.

We think that the student who carefully and conscientiously follows the course of instruction here given is in a fair way to become an accurate worker. The introductory memoranda are worthy of being engraved in the mind of every beginner. We are especially delighted with the closing paragraph, which shows that the authors look upon the student as an embryo discoverer who, not content with fixing in his own mind what has been already ascertained, is to add his quota to the sum-total of human knowledge: "Nor, again, give up hopes of making discoveries in the science because the land already appears to be highly farmed and you have not all the refined apparatus which the optician and the operative chemist can supply. Records of close and accurate observations of some of the (apparently) simplest phenomena of chemistry are much needed; and such it is in the power of every student to contribute."

We feel bound to wish this book a wide circulation and appreciative readers, or rather workers.

The Electric Light in Buchanan Street, Glasgow.—The first application in Glasgow of electricity to street lighting in a permanent form took place recently at the new *Herald* Buildings in Buchanan Street. The proprietors have also contracted with Messrs. Anderson and Munro, electric engineers, Glasgow, to light up the public offices and the composing rooms of the *Herald* and the *Evening Times* by electricity. The Gramme machines are those used, driven by an Otto gas-engine, supplied by Messrs. P. Watt and Sons—gas thus curiously so far superseding itself. This gas-engine also works the cyclic elevator in use during the day. The electric lamps are those invented by Mr. Brockie, formerly of Glasgow.

CORRESPONDENCE.

HISTORY OF BLEACHING-POWDER.

To the Editor of the Chemical News.

SIR,—In his paper (CHEMICAL NEWS, vol. xli., p. 1) Dr. Lunge says that the two compounds $Ca(OCl)_2+CaCl_2$ "are assumed by most chemists to exist in *solutions* of bleach."

Dr. Lunge appears to have forgotten my paper on this subject, published in the *Journal of the Chemical Society* for May, 1875, wherein were described the proceedings whereby I had succeeded in isolating tolerably pure calcic hypochlorite from solutions of bleaching-powder.

Perhaps I may be excused for regarding my investigation as one which furnished the strongest proof of the correctness of Odling's formula for bleach.—I am, &c.,

C. W. KINGZETT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 23, December 6, 1880.

Spectral Reaction of Chlorine and Bromine.—M. Lecoq de Boisbaudran.—If we observe in the gas flame, by the old procedure, the spectrum of a little globule of barium chloride, the rays peculiar to this compound soon disappear, and give place to those of the oxide. Still chlorine remains for a long time in the baryta thus heated, and the destruction of the barium chloride is only complete after its volatilisation. Thus on passing the induction-spark over the ignited mass we see very distinctly the nebulous rays peculiar to barium chloride, in addition to the narrow rays of barium. For the detection of traces of chlorine or bromine I proceed as follows:—A straight platinum wire, of about ½ m.m. in diameter, is bent at its lower part in the form of a hook, or of a U. Upon the bend is melted, at white redness, from 0·001 to 0·002 grm. of pure barium carbonate, and then there is placed in the curve of the wire a small drop of the liquid to be examined; it is evaporated to dryness, and the heat is pushed for a moment to incipient redness. The fusion, partially at least, of the mass is advantageous, permitting it to spread like a varnish over the surface of the platinum wire. When it is cold a second platinum wire, of about ½ m.m. in diameter, is brought very near (0·001 to 0·0015 metre), below the curve of the first wire and a little in advance of the slit of the spectroscope. The induction-spark, not condensed, gives then a spectrum in which the rays of barium chloride or bromide may be detected. About 1-3000th of a m.grm. of chlorine or bromine may thus be recognised, and doubtless with special precautions even this degree of sensibility may be surpassed, especially in case of chlorine. If the quantity of chlorine is at all considerable the wire may be heated to full whiteness for some minutes without prejudice to the rays of $BaCl_2$. The resistance of the bromide to heat seems to be much less. If the matter in question contains nitrates it is useful to expel the nitric acid with sulphuric acid, and remove this again with pure barium oxide.

On Radiophony.—E. Mercadier.—The author gives the name radiophony to the phenomenon lately observed by M. G. Bell, in which a radiation rendered intermittent according to a given period produces, on falling upon bodies cut in plates, a sound of the same period. He finds that radiophony does not appear to be an effect produced by the mass of the recipient plate vibrating transversely in its totality like an ordinary vibrating plate. The nature of the molecules of the recipient and their mode of aggregation do not seem to exert a predominating influence upon the nature of the sounds produced. The radiophonic sounds result from the direct action of the radiations upon the recipients, and principally a surface action. The effects are relatively very intense, and seem to be principally produced by the so-called thermic radiations.

On the Existence of Perboric Compounds.—A. Etard.—The author refers to a former paper, in which he places boron at the head of the vanadium group of elements. He has obtained barium perborate,—

$$Bo_2O_7BaH_4+H_2O,$$

a white, amorphous, insoluble salt, which at 100° loses 1 mol. water, and at dull redness is converted into barium borate, losing 24·2 per cent of water and oxygen. He finds, also, that whilst an equimolecular mixture of magnesium sulphate, ammonium chloride, and ammonia is not rendered turbid either by oxygenated water or by boric acid, a mixture of the two precipitate it abundantly, acting as perboric acid.

On the Cobaltamines.—N. Porumbaru.—The author has prepared and examined purpureo-cobaltamine pyrophosphate.

Researches on the Saxifrages.—MM. Garreau and Machelart.—The authors have extracted from the stems of these plants tannin, starch, and a new proximate principle, bergenine, which possesses valuable medicinal properties, and may rank between quinine and salicine.

Chemisches Central-blatt.
No. 29, 1880.

Contamination of Platinum Chloride with Gold Chloride.—W. Gintl. — This impurity is due to gold which has been used for soldering platinum vessels, and is very inconvenient in the determination of alkali. It is removed by shaking up the concentrated solution with ether.

On Hop-Bitter and Hop-Resin.—M. Issleib.—The author recognises a peculiar bitter principle both in hops and in lupuline. It is decomposed by acids, but yields no sugar, and hence belongs to the pseudo-glucosides. The lupuliretine thus obtained differs from hop-resin by the absence of H_2O.—*Archiv. Pharm.*, 16, 345.

On Cynurenic Acid.—L. Brieger.—The author examines the yellow matter obtained by Baumann on adding bromine water to solutions of cynurenic acid.—*Z. f. Phys. Chem.*, 4, 89-92.

Volatile Phenols whose Ether Sulpho-acids occur in Human Urine.—L. Brieger.—Of these compounds, paracresol is the most abundant. Phenol is found in small quantities, and orthocresol in mere traces.—*Z. f. Phys. Chem.*, 4, 204.

No. 30, 1880.

The Changes of Molecular Weight and Molecular Refractive Power.—J. V. Janovsky.—The author arrives at the result that isomers have no equal refraction-index and that the correct molecular refractive power can only be determined by means of the formula of Landolt and Gladstone and Dale, when the optical relations of the different series are known.—*Wein Anzeiger*, 103, 1880.

Solubility of Organic Bodies.—Aug. Belohoubek.—In many bodies containing carbon, hydrogen, and oxygen, the solubility depends not on the smaller number of the C-atoms, but on the number of the O-atoms in the molecule. Compounds free from oxygen are insoluble, but the richer they are in oxygen the more readily do they dissolve. Two compounds mutually dissolve each other the more similar is their structure.—*Listy. Chem.*, 4, 10.

MEETINGS FOR THE WEEK.

Monday, 17th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Geographical, 8.30.
Tuesday, 18th.—Civil Engineers, 8.
Wednesday, 19th.—Society of Arts, 8. "Causes of Success and Failure in Modern Gold Mining," Alfred G. Lock, F.R.G.S.
—— Meterological, (Anniversary), 7.
—— Geological, 8.
Thursday, 20th.—London Institution, 7.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
—— Chemical, 8. "On some Hydrocarbons Present in Resin Spirit," H. E. Armstrong, F.R.S. "Determination of the Relative Weight of Single Molecules," E. Vogel. "On the Oxidation of Organic Matter in Water," Arthur Downes, M.D. "Analyses of Queensland Soils," Prof. Liversidge.
Friday, 21st.—Royal Institution, 8. "The Phenomena of Electric Discharge with 14,400 Chloride of Silver Cells," Mr. Warren De La Rue, 9.
—— Society of Arts, 8. "Forest Conservancy in India," Sir Richard Temple, Bart., G.C.S.I.
Saturday, 22nd.—Physical, 3. "On the Measurement of Small Resistances and on a Method of Comparing the Capacities of Two Condensers," R. T. Glazebrook.

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THE CHEMICAL NEWS.

VOL. XLIII. No. 1104.

ON THE ABSORPTION SPECTRA OF COBALT SALTS.*

By W. J. RUSSELL, Ph.D., F.R.S.,
Treas. C.S., Lecturer on Chemistry at the Medical School, St. Bartholomew's Hospital.

THE following investigation was commenced with Mr. Lockyer, and although he has been unable to continue the work, the author is indebted to him for much aid and many suggestions.

The cobalt salt first examined was the anhydrous chloride. In order to establish clearly its absorption spectra, different samples of this salt were made by various processes. All, however, gave the same spectrum. The bromide of cobalt yields a similar spectrum, but its position is different—it is nearer to the red.

On fusing cobalt chloride with potassic chloride, a greenish blue mass is formed, which gives a spectrum entirely different from that of the chloride when alone. Judging from the fusing-point of the mixture being lower than that of the components, and the cobalt salt not decomposing in this mixture on fusion in contact with air, it seemed natural to suppose that a new compound had been formed, and that it gave rise to the new spectrum. Further experiment showed, however, that this is not the case for other solid chlorides, such as of sodium and zinc give with cobalt chloride the same spectrum; and liquids in which the cobalt chloride easily dissolves, such as ordinary or amylic alcohol, the saline ethers, glycerine, and hydrochloric acid, also give the same spectrum; in fact, this spectrum is produced whenever cobalt chloride dissolves freely in any menstruum without definitely combining with it. A careful set of experiments were made in the case of the solid chlorides, to exclude the presence of water, for it was possible that the spectrum in all the above cases might be due to a trace of water, which, by its combining with the cobalt chloride, formed in every instance the spectrum-giving body.

The bromide and iodide of cobalt, when fused with potassium bromide and potassium iodide respectively, give results corresponding to those of the chloride, but the bands in the spectrum of the bromide, and still more so those of the iodide, are nearer to the red than the corresponding bands of the chloride. The action of heat and of water on the bodies producing these spectra is discussed, and it is pointed out how the definite compound with zinc was indicated by the spectrum. The action of the liquids which easily dissolve the cobalt chloride is next described, and from all giving the same spectrum, and this spectrum being identical with that obtained with the fused chlorides, the conclusion is that, as before stated, this spectrum must be that of the cobalt chloride, only, owing to solution, it is in a molecular state, different from that obtained on fusing this salt alone. This spectrum, as obtained from the hydrochloric acid solution, is remarkable for its persistence under varying circumstances, and for its being a reaction of great delicacy.

Hydrochloric acid as a solvent for the cobalt chloride differs in one respect from all the other solvents which have as yet been examined, namely, that, whether much or little cobalt be dissolved in it, the spectrum is the same; whereas with dry alcohol, for instance, a saturated, or nearly saturated, solution gives the spectrum above mentioned, but a diluted solution, one containing about 20 grms. of the chloride in 100 c.c. of alcohol, gives a spectrum somewhat different: a new band appears and others present before fade out, and if this dilution be carried on still further, so that only about 0·008 grm. of the chloride be present in 100 c.c. of alcohol, an entirely different spectrum is obtained, but on carrying the dilution beyond this no further change takes place. With other liquids which dissolve the cobalt salt freely, a similar series of changes occur, but if liquids in which the chloride is much less soluble be used, then according to their solvent power only the first (or most dilute stage), or the first and second stage, is obtainable; for instance, if dry ether is used as the solvent, it yields only a spectrum corresponding to the first stage. With anhydrous acetic acid, in which the cobalt chloride is more freely soluble, both the first and second stage are obtainable. If the dry chloride in fine powder be shaken up with the liquid in which it is insoluble, such as carbon tetrachloride, then only a spectrum similar to that of the fused chloride is visible.

The anhydrous cobalt chloride dissolved in water gives a pink solution. This solution, when it contains as little as 0·1 grm., or as much as 25 grms., of the salt in 100 c.c. of water, gives a wide absorption-band, shading off on both sides, and whether a short column of the strong solution or a correspondingly long column of the dilute solution be examined, identical spectra are obtained, so that within these limits the same compound appears to exist in the solution. If, however, the solution approaches saturation (100 c.c. of water can dissolve at 16° 32 grms. of the cobalt chloride), then another spectrum is visible, and this is again the spectrum of the dissolved chloride. The same as was shown to be obtained either by dissolving cobalt chloride in fused patassium chloride, or in alcohol, or in hydrochloric acid, it is apparently the anhydrous chloride existing in an aqueous solution. The action of heat, and the action of bodies capable of combining with water, in aqueous solutions of cobalt chloride, are identical, both tending to destroy the broad absorption-band of the hydrate, and to form the banded spectrum of the dissolved anhydrous chloride.

The very characteristic spectrum of the oxide of cobalt is well known. The precipitate obtained by the addition of potash or soda to any cobaltous salt shows well this spectrum. If ammonia be the precipitate, a somewhat simpler spectrum is obtained. Vogel has already pointed out the similarity of the spectrum of a piece of cobalt glass and this oxide spectrum. The glass spectrum is apparently identical with the spectrum formed by the precipitate with potash and soda; probably then the extra band visible in these cases and not when ammonia is used, is due to a compound of the alkali and cobalt. The bearing of these spectra on Winkler's supposed cobaltate of potash is then discussed. Further, it is shown that if the above precipitation of oxide be made in solutions in which the cobalt salt is in excess, or even if precipitated oxide be warmed or shaken up in the cold with a solution of cobalt chloride, a new compound is formed, an oxychloride which gives a different spectrum; its formation and its decomposition by water is well traced in the varying spectra producible from it, and goes hand in hand with the chemical changes which occur. From the spectroscopic appearance it is argued that the blue precipitated oxide is not a hydrate, but that it does very readily undergo change as the mere alteration of colour which takes place shows. Aqueous solutions of the bromide and iodide of cobalt when acted on by alkalies undergo changes similar to those which the chloride undergoes, and, as in the former cases, the iodide spectrum is always nearer the red end of the spectrum than the corresponding bromide spectrum, and the bromide than the chloride spectrum.

The salts of the oxygen acids when in aqueous solution do not give sharp banded spectra as the haloid salts do, but only a large shading off absorption like the hydrate of the cobalt chloride.

The other points discussed in detail are, first, the nature of the precipitate formed by the action of sodic or potassic carbonate on a cobaltous salt, and it is shown that the formation of the oxide always found in this precipitate is

* Abstract of a paper read before the Royal Society, November 18, 1880.

owing to an after decomposition, the precipitate as first formed being entirely free from all oxide, and it gradually appearing after a short time. The other point is the action of heat on cobalt phosphate dissolved in fused microcosmic salt; when cold there appears somewhat indistinctly a banded spectrum of a phosphate; on heating this the spectrum disappears, and the spectrum of the oxide very distinctly takes its place; on cooling, the first spectrum returns, and this change may apparently be repeated any number of times.

Drawings of all the different spectra are given in the full paper.

NOTE ON CHICKEN CHOLERA.

By C. T. KINGZETT, F.C.S., F.I.C.

Many readers of the important communications which Pasteur has recently made to the Academy of Sciences, and translations of which have appeared in recent issues of the Chemical News (vol. xlii., p. 321, and vol. xliii., pp. 5 and 16), must have remarked that which I now wish to point out.

In explaining the protective influence of repeated inoculations with the attenuated virus of chicken cholera, against the more virulent forms of this disease, Pasteur finds it "impossible to resist the idea that the microscopic germ which causes the disease, finds in the body of the animal conditions suitable to its development, and that to satisfy the necessities of its life the germ alters certain substances, or destroys them, which comes to the same thing, whether it assimilates them or whether it consumes them with oxygen borrowed from the blood."

So, again, in cases where complete immunity has been attained, the birds "no longer contain food for the germ."

More striking still is the following passage in reference to chickens which are born proof against cholera:—"Animals in this condition may be said to be born vaccinated for this disease, because the fœtal evolution has not placed in their bodies the proper food of the parasite, or because substances which could serve as such food have disappeared while they were yet young."

Now whether or not we may be prepared to regard the said parasite as the direct cause of the disease, it is remarkable that the reasoning of Pasteur should have culminated in the conclusion upon which Liebig insisted with considerable power.

If we turn to Gregory's (3rd) edition of Liebig's "Animal Chemistry" (p. 205) we find the following passage:—"The condition which determines, in a second individual, his liability to the contagion, is the presence in his body of a substance which by itself, or by means of the vital force acting in the organism, offers no resistance to the cause of change in form and composition operating on it. If this substance be a necessary constituent of the body, then the disease must be communicable to all persons; if it be an accidental constituent, then only those persons will be attacked by the disease in whom it is present in the proper quantity and of the proper composition. The course of the disease is the destruction and removal of this substance: it is the establishment of an equilibrium between the cause acting in the organism which determines the normal performance of its functions and a foreign power by whose influence these functions are altered."

I repeat that to me it seems somewhat remarkable that the investigations and reasoning of two such eminent (and in many matters diametrically opposed) thinkers should have culminated in the same conclusion as regards the conditions of the living body which subject it to, or protect it from, infection.

While, however, it can be readily understood how a profuse growth of parasites could quickly alter or destroy a comparatively large amount of substance—as, for instance, happens in ordinary putrefaction—it does not appear to me so easy to accept Pasteur's reasoning as to his so-called vaccination.

In this inflicted process an attenuated virus is introduced into the body of a chicken which becomes ill but does not die. It does not die because, if Pasteur be correct, the parasites do not sufficiently multiply. Why do they not multiply? It cannot be on account of the insufficiency of the pabulum, for in the large majority of cases where death results this seems to arise from the very profusion of the growth of the parasite when more freely introduced.

Can it be expected, therefore, that even, say, in three successive inoculations the substance which I have here spoken of as pabulum can be entirely removed or destroyed by the very limited number of parasites which are introduced by the inoculations, and which so soon perish in the body? I think this cannot be expected; but if it may be, then the particular substance or substances upon which the parasites prey must be extremely limited in quantity. After all, we are faced with the enormous difficulty of ascertaining the nature of such substance, and the further equally great difficulty of understanding why an undiscovered and undetermined substance should be entirely absent from the bodies of some animals and present in varying proportions in others.

Here we come in contact with the weakest point in the parasitic theory. The immunity from a second attack of an infectious disease of the class in question is simply inexplicable under the parasitic theory. We are forced back to an alternative theory, and that is one of which we at present only recognise the beginnings.

ON THE GRAINS OF SILICA AND MICROCOCCI OF THE ATMOSPHERE.

By Dr. T. L. PHIPSON, F.C.S., &c.

At the period of the great debate on spontaneous generation between M. Pasteur and Pouchet, the latter was the first to draw attention to the fact that some of the minute spherical granulations discovered by the microscope in dust deposited from the air in various regions of the globe, were essentially composed of silica. That they had often been mistaken for eggs of infusoria or for micrococci was very evident; but when the dust was submitted to complete calcination in a platinum crucible the same grains were still visible, with the same forms and dimensions as before.

I have more than once repeated this experiment of Pouchet's, but I have also made the opposite one and examined the action of heat upon micrococci, diatoms, and oscillariæ, which are supposed to contain large quantities of silica.

There is no doubt that the dust of the atmosphere reveals to the microscope, besides the larger mineral fragments mostly of an angular shape, exceedingly minute circular or spherical bodies, having often not more than 0·001 of a millimetre in diameter, and very similar in size and shape, which resist the action of a white heat in contact with the air, and that of strong hydrochloric acid. In some of my observations they were remarkably numerous. Both before and after the action of heat they are more or less transparent. What can be the origin of these singular objects?

The same experiments repeated with siliceous algæ, such as those belonging to the large family of the *diatomaceæ*, and with the *micrococci* of impure waters or vegetable infusions, showed me that they do not retain their forms after being subjected to the above treatment, and that in many instances they can be totally destroyed by heat on the object glass itself. On the other hand, the fossil diatoms resisted the action of heat and acids and retained their forms. I can only draw one conclusion from these observations: namely, that the minute siliceous bodies found in the atmosphere are also fossil—they are micrococci of another age.

SOME EXPERIMENTS ON MALTOSE.*

By H. YOSHIDA,
Graduate of the University of Tokio, Japan.

The maltose used in the following experiments was extracted from a substance called *amé*, used in Japan as a sweetmeat, as well as for some other purposes. This substance is prepared from steamed rice by the action of an extract of malt, and when boiled down forms a clear yellow thickly viscid liquid. Different specimens contain from 45 to 75 per cent maltose, 8 to 38 per cent dextrin, and 8 to 16 per cent of water. The separation of the maltose from the dextrin was effected by their different solubilities in strong alcohol, and subsequent crystallisation from that solution. 300 c.c. of the *amé* syrup were diluted with a little water, then poured into a flask containing two litres of alcohol of specific gravity 0·83, and the whole boiled for about thirty minutes. The flask was provided with an inverted condenser to prevent loss of alcohol. The flask was then removed from the water-bath, and after cooling the liquid was filtered from the pasty mass of dextrin. The several alcoholic extracts obtained in this way were distilled over the water-bath until almost the whole of the alcohol was removed, and the liquid reduced to about one-eighth of its volume. This syrup was again exhausted with twice its volume of strong alcohol (sp. gr. = 0·8) with slight warming. After cooling the solution was decanted and set aside; after three days, crystals of maltose had formed, which were purified by re-crystallisation until the properties of the substance showed that it was pure. This was the case after the third crystallisation.

The specific rotatory power was determined by means of a Soleil Ventzky saccharimeter by the use of the formula—

$$[\alpha]j = \frac{n \times 0{\cdot}3961}{l \times m}$$

Where n = number of divisions through which the scale was turned.

l = length of tube in decimeters.

m = number of grains of solid matter in 1 c.c. of solution.

The number 0·3961 for converting divisions into degrees of rotation was determined by Mr. U. Watanabe very carefully with a solution of pure cane-sugar, using the number 73·8° to express the specific rotatory power of cane-sugar for the transition-tint. Experimenting with the maltose above obtained the following are the results:—

Table I.

m. Grains of Maltose in 1 c.c. of Solution.	*l.* Length of Tube.	*n.* Divisions Rotated.	$[\alpha]j$. Specific rotatory Power.
0·0642 gr.	2	48·7	150·1
0·0642 ,,	2	48·8	150·5
0·1000 ,,	2	75·8	150·1
0·1000 ,,	2	76·0	150·4
		Mean ..	150·25

The cupric oxide reducing power was determined by weighing the cupric oxide obtained by igniting the red oxide thrown down with the addition of a few drops of hydric nitrate. The maltose solution contained 8·196 grs. in 1 litre. 40 c.c. of Fehling's solution were diluted with about 200 c.c. of water, heated in a water-bath, and 20 c.c. of the above solution of maltose added, and the heating continued for twenty minutes. The reduced cuprous oxide was rapidly filtered, well washed, and finally burnt after the addition of a few drops of hydric nitrate, and weighed. The weight of cupric oxide obtained was in four experiments, 0·2206, 0·2203, 0·2211, 0·2205; mean, 0·2206 gr. CuO. The amount of maltose used was 0·1639 gr., and—

$$\frac{0{\cdot}1639}{0{\cdot}2206} = \frac{\text{mol. weight of maltose}}{n \times \text{mol. weight CuO}} = \frac{342}{5{\cdot}81 \times 79{\cdot}2}$$

1 molecule of maltose, therefore, corresponds to 5·81 molecules of cupric oxide, the equivalent number for glucose being 5. The cupric oxide reducing power calculated for this is—

$$\chi = \frac{100 \times 100}{0{\cdot}1639} = 61{\cdot}01.$$

Mr. O'Sullivan gives it = 65, while Messrs. Brown and Heron make it 60·8 as a mean of six experiments. The number above obtained may be a little too high, but is much nearer to the result obtained by the later observers.

Experiments were next made with the ammoniacal solution of tartrate of copper, recommended by Dr. Pavy in 1879. This method is based upon the complete solubility of cuprous oxide in strong ammonia, the result being the formation of a colourless liquid, and by noting the amount of sugar solution required to decolourise a given volume of the ammoniacal copper solution, the quantity of the sugar in a given sample can easily be calculated. The solution was first prepared according to Dr. Pavy's directions: 120 c.c. of the ordinary Fehling's solution were mixed with 300 c.c. of ammonia (sp. gr. = 0·88), and the whole made up to 1 litre.

The process was first tested with dextrose, and afterwards with maltose. The results are given together in the following tables. 1 c.c. of the dextrose solution used contained 0·005 grm., and that of the maltose 0·0081936 grm. The amount of copper solution used in each experiment was 40 c.c. (CuO = 0·0529776 grm.).

Table II.

	Copper solution used. c.c.	Dextrose solution required. c.c.	Maltose solution required. c.c.
1.	40	4·8	5·2
2.	40	4·75	5·2
3.	40	4·75	5·2
4.	40	4·80	5·2
	Mean ..	4·77	5·2
Ratio of molecule of sugar to cupric oxide ..		1 : 5·03	1 : 5·38

With the addition of 10 grms. of caustic potash to 40 c.c. of the original ammoniacal copper solution, the results given in Table III. were obtained.

Table III.

	Copper solution used. c.c.	Dextrose solution required. c.c.	Maltose solution required. c.c.
1.	40	4·0	4·30
2.	40	4·1	4·25
3.	40	4·0	4·30
4.	40	4·0	4·30
	Mean ..	4·02	4·29
Ratio of sugar to cupric oxide ..		1 : 6	1 : 6·5

Further experiments were made to ascertain the effect of using different strengths of ammonia in preparing the copper solution. Table IV. gives the results obtained with a copper solution prepared with 300 c.c. of ammonia of sp. gr. 0·93, other things as before.

Table IV.

	Copper solution used. c.c.	Dextrose solution required. c.c.	Maltose solution required. c.c.
1.	40	4·0	5·1
2.	40	4·0	5·1
3.	40	3·95	5·05
4.	40	4·0	5·15
	Mean ..	3·99	5·1
Ratio of sugar to cupric oxide ..		1 : 6	1 : 5·5

* Abstract of a thesis presented on graduating, July, 1880.—R.W.A.

With the addition of 10 grains of potash to 40 c.c. of the solution prepared as above described, the results in Table V. were obtained.

Table V.

	Copper solution used. c.c.	Dextrose solution required. c.c.	Maltose solution required. c.c.
1.	40	4·65	4·1
2.	40	4·75	4·15
3.	40	4·75	4·1
4.	40	4·65	4·1
	Mean ..	4·70	4·11
Ratio of sugar to cupric oxide	..	1 : 5·1	1 : 6·8

A third copper solution was prepared by using 350 c.c. of ammonia of specific gravity 0·88.

Table VI.

	Copper solution used c.c.	Dextrose solution required. c.c.	Maltose solution required. c.c.
1.	40	3·8	5·3
2.	40	3·85	5·25
3.	40	3·80	5·35
4.	40	3·75	5·3
	Mean ..	3·8	5·3
Ratio of sugar to cupric oxide	..	1 : 6·3	1 : 5·2

It will be seen from these results that the ratio of the number of molecules of sugar and of cupric oxide found by experiment is greatly influenced by slight differences in the strength of the ammonia employed, so that whenever this test is resorted to, the copper solution must be standardised against a known amount of sugar before it can be used. With dextrose the ratio of 1 : 5 is obtainable only by the use of ammonia of the strength and amount recommended by Dr. Pavey. The same ratio does not hold for maltose solutions, but it is to be noticed that differences in the strength of the ammonia used cause less marked changes than in the case of dextrose.

The addition of an extra amount of potash, however, appears to increase very largely the oxidising action of the copper solution upon maltose. The reduction of copper solution by maltose also takes place much more slowly than with dextrose.

In heating the solution the burette was joined by a piece of india-rubber tubing to a piece of glass tube, which ended in a fine point, and was bent so as to remove the flask in which the liquid was heated away from the neighbourhood of the burette.

In this way the sugar solution was not heated by the hot air rising from the sand bath upon which the flask rested.

The ammonia vapours were led into water.

The accompanying figure shows the arrangement of the apparatus.

Action of Hydric Nitrate on Maltose.—The method of Heintz for preparing saccharic acid from cane sugar was exactly followed as described in "Watts's Dictionary," vol. v., p. 142. The solution of the acid potassium salt after four crystallisations from hot water yielded distinct prisms of a light straw-colour. The acid was prepared according to the directions given by Baltzer (*Bull. Soc. Chim.*, 1868, p. 263) by carefully neutralising the solution of the acid salt with potassic carbonate, then boiling the solution with the addition of a small quantity of cadmic nitrate for one hour. The precipitate was collected, decomposed by sulphuretted hydrogen, and the solution evaporated at a temperature of 30° C. and finally over oil of vitriol *in vacuo*. A light coloured brittle mass was obtained, which on combustion gave the following numbers:—

1. 0·5234 grm. gave 0·6521 grm. CO_2 and 0·2271 grm. H_2O
2. 0·6344 ,, 0·7909 ,, 2·2975 grm. H_2O

	I.	II.	Mean.	Calculated for $C_6H_{10}O_8$.
Carbon ..	33·98	34·00	33·99	34·29
Hydrogen ..	4·82	5·21	5·02	4·76

The acid was highly deliquescent, soluble in alcohol, and its colour darkened when heated on the water-bath. A smooth mirror of reduced silver was obtained when a mixture of the acid and silver nitrate with ammonia was heated. Although therefore the percentage of hydrogen found is not very good, the percentage of carbon and the properties of the substance indicate that it really is saccharic acid.

A portion of the acid potassium salt was ignited, and the potassium weighed as sulphates. The potassium in two experiments was found to be 19·62 per cent and 19·15 per cent. The calculated percentage is 15·77, and it is evident, therefore, that the salt was impure, and probably contained in admixture some of the normal salt. Another portion of the crystals was dissolved in water, and completely neutralised with potassic carbonate, evaporated, and allowed to stand. A crystalline deposit separated, which was collected, re-crystallised, and the potassium determined as sulphates.

	I.	II.	Mean.	Calculated $C_6H_8K_2O_8$.
Potassium..	27·41 per cent	27·52	27·46	27·34

There is, therefore, little doubt that that saccharic acid is formed by the action of hydric nitrate upon maltose.

Action of Chlorine in presence of Water upon Maltose.—About 10 grains of maltose were dissolved in half a litre of water, and a stream of chlorine gas passed through the solution for three days. The excess of chlorine was then expelled by a stream of carbonic acid, and the clear colourless solution then heated over the water-bath and completely neutralised with freshly prepared moist oxide of silver. The liquid was quickly filtered, and the residue repeatedly washed with boiling water. The brownish coloured filtrate, which had now become somewhat turbid, was subjected to the action of hydric sulphide gas, the precipated argentic sulphide filtered off, and the acid solution concentrated over the water-bath. After neutralising with milk of lime, the filtered solution was precipitated by lead acetate, and the precipitate after washing decomposed by sulphuretted hydrogen. This solution on evaporation yielded a dark, very acid syrup, which did not become dry, even after long standing over oil of vitriol *in vacuo*. A portion of the syrup was dissolved in a small amount of water, completely neutralised with milk of lime, and filtered. On heating the filtrate to 100° C. a crystalline deposit separated, which was collected and re-crystallised. After drying at 118—120° C. it gave the following numbers on analysis:

1. 0·6244 grm. substance gave 0·5842 grm. CO_2; 0·2429 grm. H_2O; and 0·2678 grm. residue.
2. 0·7831 grm. substance gave 0·7371 grm. CO_2; 0·3108 grm. H_2O; and 0·3338 grm. residue.

These numbers give—

	1.	2.	Mean.
Carbon..	25·52	25·67	25·59
Hydrogen	4·32	4·41	4·36
Residue ($CaCO_3$)	42·88	42·62	42·70

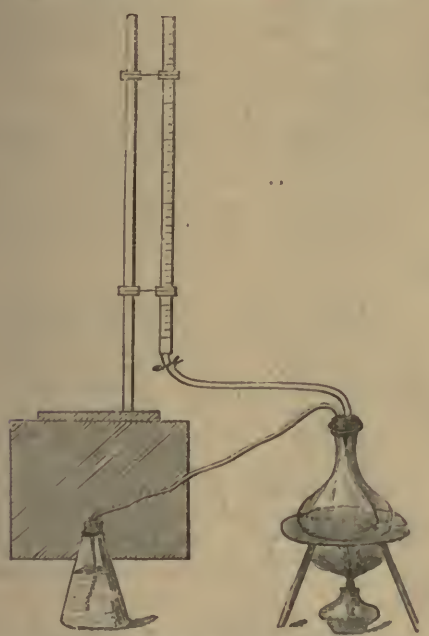
And if we add the carbon contained in the residue we get the following:—

	Mean of 1 and 2	Calculated for $C_6H_{10}CaO_7$.
Carbon	30·72	30·77
Hydrogen	4·46	4·27
Calcium	17·08	17·08
Oxygen (difference)	47·74	47·88
	100·00	100·00

Another sample ignited over the blowpipe gave the following amount of lime (CaO):—

	P.c. Ca.
1. 0·5431 grm. substance gave 0·1310 grm. CaO	= 17·23
2. 0·4462 „ „ 0·1061 „	= 16·69
Mean	17·11

Maltose, therefore, like cane-sugar and dextrose, yields gluconic acid on oxidation with chlorine in presence of water. Experiments were made, using potassic permanganate to oxidise the maltose, but no conclusive results were obtained. Much heat was evolved during the reaction, and the solution, after removing manganese by sulphuretted hydrogen, gave a white precipitate with calcic chloride, which, after being dried at 100° C., contained in two experiments 33·03 and 33·11 per cent of calcium. Calcic oxalate contains 31·25 per cent of calcium.



Action of Glacial Acetic Acid upon Maltose.—A mixture of 2 parts of maltose, 1 part of acetic anhydride, and 5 parts of glacial acetic acid were heated to 110° C. in an open vessel. A dark coloured mass was obtained, which was found to be a mixture of several bodies. It was first treated with warm water: the filtrate, after evaporation, was exhausted with alcohol, and the solution filtered. The alcoholic solution was then mixed with twice its volume of ether, which precipitated a small quantity of a light yellow body. After being dried at 100° C. the substance gave the following numbers on combustion:—

1. 0·4321 grm. substance gave 0·6805 grm. CO_2 and 0·273 grm. H_2O.
2. 0·5224 grm. substance gave 0·8317 grm. CO_2 and 0·3174 grm. H_2O.

	1.	2.	Mean.	Calculated for $C_{12}H_{11}O_{11}(C_2H_3O)$.
Carbon..	42·95	43·42	43·19	43·75
Hydrogen	7·02	6·75	6·88	6·25

The numbers are not as close as might be desired, but considering the difficulty of purification they indicate that the substance insoluble in ether was the mon-acetyl derivation of maltose. It was at first sweet to the taste, but became afterwards bitter; it reduced Fehling's solution.

The other portions were not further examined owing to press of time.

ON THE

APPLICATION OF ORGANIC ACIDS TO THE EXAMINATION OF MINERALS.*

(SECOND PAPER)

By H. CARRINGTON BOLTON, Ph.D.

26. THE behaviour of minerals with organic acids has already formed the subject-matter of two papers read before the Academy in 1877 and 1878, and we now present the results of a continuation of our researches.

In our first paper† we described several new methods of attacking minerals, and their application to ninety-five specimens; in this we extend our investigation to one hundred and five additional minerals. These methods of decomposition were as follows:—

(1.) Treatment with a cold saturated solution of citric acid.
(2.) Treatment with a boiling solution of the same.
(3.) Heating with a saturated solution of citric acid to which sodium nitrate is added.
(4.) Heating with a saturated solution of citric acid to which ammonium fluoride is added.

And in a second paper, under another title,‡ we added a fifth reaction:—

(5.) Heating with a concentrated solution of citric acid to which potassium iodide is added.

Similar reactions with oxalic, tartaric, acetic, and other organic acids were described in the first paper, but preference is given to citric acid on account of its greater solvent power.

Minerals belonging to several groups were submitted to these processes, and gave phenomena which may be summarised as follows:

(1.) More or less complete decomposition and solution of oxides, phosphates, &c., without formation of precipitates or liberation of gases.
(2.) Complete solution of carbonates with evolution of carbonic anhydride.
(3.) Decomposition of sulphides with evolution of sulphuretted hydrogen.
(4.) Decomposition of sulphides with oxidation of the sulphur.
(5.) More or less perfect decomposition of silicates with separation of either slimy or gelatinous silica.
(6.) Decomposition of certain species by reagents forming characteristic precipitates.
(7.) Wholly negative action.

These facts demonstrated that citric acid has a power of decomposing minerals little less than that possessed by hydrochloric acid, and that this very difference in degree gives the organic acid an advantage over the mineral acid in the determination of species.

27. This peculiar selective power of citric acid rendered desirable a further study of its action on a larger number of minerals; the following list contains the names of the species which have since been submitted to the process named, together with their formulæ, condition, and locality.

Within the groups,—(1), sulphides, arsenides, tellurides, &c.,—(2), oxides,—(3), silicates, and—(4), sundries, the minerals are arranged in the order in which they are given in "Dana's System of Mineralogy."

We desire to express our thanks to Prof. Thomas Egleston, of the School of Mines, Columbia College, who has again placed us under obligations by supplying many of the rarer minerals.

* Read before the New York Academy of Sciences and the Chemical Section of the British Association, Swansea Meeting, 1880.
† *Annals N.Y. Acad. Sci.*, vol., 1, p. 1.
‡ "Behaviour of Natural Sulphides with Iodine and Other Reagents." *Annals N.Y. Acad. Sci.*, vol. i., p. 153.

I. SULPHIDES, ARSENIDES, &c.

Mineral.	Formula.	Description.	Locality.
Sulphur	S_2	massive	Humboldt, Nev.
Realgar	AsS	crystalline	Hungary.
Orpiment	As_2S_3	crystals	Hungary.
Bismuthinite	Bi_2S_2	in quartz	Clear Creek, Col.
Domeykite	Cu_3As_2	massive	Chili, S.A.
Clausthalite	PbSe	———	Tilkerode, Hartz.
Alabandite	MnS	crystalline	Mexico.
Hessite	AgTe	———	Boulder, Col.
Tiemannite	HgSe	incrusting	Clausthal, Hartz.
Millerite	NiS	crystalline	Lancaster Co., Pa.
Linnaeite	$2CoS+CoS_2$	crystals	Müsen, Prussia.
Cobaltite	$Co(S,As)_2$	grains	Tanaberg, Sweden.
Leucopyrite	$FeAs_2$	massive	Breitenbrun, Saxony.
Nagyagite	$2(Pb,Au)+3(Te,Sb,S.)$	foliated	Austria.
Covellite	CuS_2	massive	Germany.
Berthierite	$FeS+Sb_2S_3$	crystalline	Braunsdorff, Saxony.
Jamesonite	$2(Pb,Fe)S+Sb_2S_3$	fibrous	———
Pyragyrite	$3AgS+Sb_2S_3$	massive	Chili.
Proustite	$3AgS+As_2S_3$	massive	Chili.
Boulangerite	$3PbS+Sb_2S_3$	massive	———
Tennantite	$4(CuFe)S+As_2S_3$	crystalline	Cornwall, England.
Stephanite	$5AgS+Sb_2S_3$	massive	Mexico.
Polybasite	$9(AgCu)S+(Sb,As)_2S_3$	massive	———
Enargite	$3CuS+As_2S_5$	massive	Gilpin, Co., Colorado.
Kermesite	$2SbS_3+SbO_3$	crystalline	Braunsdorff, Saxony.

II. OXIDES.

Melaconite	CuO	massive	Copper Harbour, L.S.
Corundum	Al_2O_3	white, massive	North Carolina.
Menaccanite	$(Ti,Fe)_2O_3$	crystals	Ilmen Mts., Russia.
Washingtonite	$(Ti,Fe)_2O_3$	crystals	Litchfield, Conn.
Spinel	$MgOAlO_3$	crystals	Franklin, N.J.
Chrysoberyl	$BeOAlO_3$	crystals	Brazil.
Cassiterite	SnO_2	crystals	Cornwall, England.
Rutile	TiO_2	crystals	York, Pa.
Braunite	$2Mn_2OMnO_2+MnO_2SiO_2$	crystalline	Thuringia.
Goethite	FeO_3HO	crystalline	Easton, Pa.
Gummite	$(UO_3FeO_3)+2HO$	amorphous	North Carolina.
Quartz	SiO_2	crystals	Conn.
Hyalite	SiO_2+aq	mammillary	Waltsch, Bohemia.

III. SILICATES.

Enstatite	$MgOSiO_2$	massive	North Carolina.
Hypersthene	$(MgOFeO)SiO_2$	massive	Labrabor.
Petalite	$(\frac{1}{2}R_3O+\frac{1}{2}RO_3)3SiO_2+3SiO_2$	massive	Sweden.
Pargasite	$(R_3ORO_3)\ (SiO_2Al\frac{2}{3}O_3)$	massive	Diana, N.Y.
Actinolite	$(CaOMgOFeO)SiO_2$	crystals	Oxbow, N.Y.
Asbestus	$(R_3ORO_3)\ (SiO_2Al\frac{2}{3}O_3)$	silky fibrous	———
Beryl	$(\frac{1}{2}Be_3O+\frac{1}{2}AlO_3)3SiO_2$	transp. crystals	Brazil.
Tephroite	Mn_2OSiO_2	massive	Franklin, N.J.
Pyrope	$(\frac{1}{2}(MgO,CaO,FeO,MnO)_3+\frac{1}{2}AlO_3)_23SiO_2$	crystals	Bohemia.
Colophonite	$(\frac{1}{2}R_3O+\frac{1}{2}RO_3)_23SiO_2$	crystals	Willsborough, N.Y.
Zircon	ZrO_2SiO_2	crystals	North Carolina.
Vesuvianite	$(\frac{2}{3}R_3O+\frac{2}{3}RO_3)3SiO_2$	crystals	Moldavia.
Allanite	$SiO_2,AlO_3,FeO,MnO,CeO,LaO,DdO,YO,2HO$	partially decomposed	Virginia.
Zoisite	$(\frac{1}{3}Ca_3O+\frac{2}{3}AlO_3)_23SiO_2$	massive	Conway, Mass.
Ilvaite	$(\frac{2}{3}R_3+\frac{2}{3}RO_3)3SiO_2$	massive	Hartz Mts.
Iolite	SiO_2,AlO_3,FeO,MgO	translucent	Finland.
Phlogopite	$(\frac{7}{11}R_3O+\frac{4}{11}RO_3)_23SiO_2$	micaceous	Montville, N.J.
Lepidolite	$SiO_2,AlO_3,FeO_3,LiO,KO,Fl$	micaceous	Paris, Maine.
Nephelite	$(\frac{1}{4}R_3O_1+\frac{3}{4}AlO_2)_23SiO_2+\frac{2}{3}SiO_2$	mixed with biotite	Vesuvius.
Lapis lazuli	SiO_2,AlO_3,CaO,NaO,S	massive	Brazil.
Leucite	$KOSiO_2+AlO_33SiO_2$	crystals	Vesuvius.
Anorthite	$(\frac{1}{4}R_3O+\frac{3}{4}AlO_3)_23SiO_2$	massive	Tunaberg, Sweden.
Oligoclase	$(\frac{1}{4}(NaO,CaO)_3+\frac{3}{4}AlO_3)_23SiO_2+3\frac{3}{4}SiO_2$	massive	Chester Co., Pa.
Andalusite	AlO_3SiO_2	crystals	Bavaria.
Fibrolite	AlO_3SiO_2	crystalline	Wilmington, Del.
Topaz	AlO_3SiO_2	crystals	Brazil.
Titanite	$(CaO+TiO_2)SiO_2$	crystals	Diana, N.Y.
Staurolite	$(\frac{1}{2}R_3O+\frac{1}{2}AlO_3)_43SiO_2$	crystals	Franconia, N.H.

III. SILICATES *(Continued)*.

Mineral.	Formula.	Description.	Locality.
Laumontite	SiO_2,AlO_3,CaO,HO	crystals	Peter's Point, N.S.
Thomsonite	$2SiO_2,AlO_3,(\frac{3}{4}CaO+\frac{1}{4}NaO),2\frac{1}{2}HO$	crystalline	Renfrewshire, Scotland.
Mesolite	$3SiO_2,AlO_3(\frac{3}{4}CaO+\frac{1}{4}NaO)+3HO$	crystalline	Peter's Point, N.S.
Herschelite	$SiO_2,AlO_3,CaO,NaO,KO,HO$	——	Cyclops, Catania.
Heulandite	$6SiO_2,AlO_3,CaO,5HO$	red, crystalline	Fassathal, Tyrol.
Bowenite	$[2MgOSiO_2+MgO2HO$	amorphous	Smithfield, R.I.
Bastite	——	massive	Germany.
Genthite	$(\frac{3}{4}(NiO_2,MgO)+\frac{1}{4}HO)2SiO_2+\frac{4}{3}HO$	amorphous	North Carolina.
Kaolin	$AlSiO_2+2HO$	pulverulent	Rossville, Staten Island.
Gieseckite	$SiO_2,AlO_3,FeO_3,MgO,CaO,NaO,HO$	massive	St. Lawrence Co., N.Y.
Jefferisite	$(\frac{3}{4}R_3O+\frac{3}{4}RO_3)_2+3SiO_2+3HO$	micaceous	West Chester, Pa.
Prochlorite	$(\frac{4}{3}(MgOFeO)_3+\frac{2}{3}AlO_3)SiO_2+\frac{4}{3}HO$	crystalline	New Bedford, Mass.
Masonite	$(\frac{1}{4}(FeMgO)_3+\frac{1}{4}AlO_3)_43SiO_2+3HO$	massive	Natic, R.I.

IV. SUNDRY MINERALS.

Atacamite	$3CuOHO+CuClHO$	granular	Chili.
Columbite	$(FeOMnO)(CbO_5TaO_5)$	crystalline	Haddam, Conn.
Mimetite	$3PbOAsO_5+PbCl$	crystals	Bohemia.
Triphylite	$(FeOMnOLiO)_3PO_5$	massive	Grafton, N.H.
Triplite	R_3OPO_5+RFl	massive	Limoges, France.
Libethenite	Cu_4OPO_5+HO	crystalline	Cornwall, England.
Olivenite	$Cu_3O(AsO_5,PO_5)+CuOHO$	crystalline	Cornwall, England.
Pseudomalachite	Cu_6OPO_5+3HO	massive-granular	Copperopolis, Utah.
Wavellite	AlO_5,PO_5,HO	crystalline	Montgomery Co., Ark.
Pharmacosiderite	$3FeO_3AsO_5+FeO_33HO+12HO$	crystalline	Cornwall, England.
Torbernite	$U_2O_3PO_5+CuOHO+7HO$	crystals	Cornwall, England.
Autunite	$U_2O_3PO_5+CaOHO+7HO$	crystals	Autun, France.
Ulexite	SiO_2,BO_3,CaO,NaO,KO,HO	nodular fibrous	Nevada.
Cryptomorphite	BO_3,CaO,NaO,HO	chalky	Oregon.
Wolframite	$(FeOMnO)WO_3$	massive	Zinnwald, Bohemia.
Hübnerite	$MnOWO_3$	massive	Nye Co., Nev.
Scheelite	$CaOWO_3$	crystals	Zinnwald, Bohemia.
Wulfenite	$PbOMoO_3$	crystals	Mies, Carinthia.
Barite	$BaOSO_3$	massive	Pillar Point, N.Y.
Celestite	$SrOSO_3$	crystals	Strontian Is., L. Erie.
Anhydrite	$CaOSO_3$	crystals	Duremberg.
Crocoite	$PbOCrO_3$	crystalline	Hungary.
Brochantite	$CuOSO_3+2\frac{1}{2}CuOHO$	crystalline	Chili.
Mercury	Hg	liquid	——
Arsenic	As	massive	Germany.
Graphite	C	foliated	Ticonderoga, N.Y.
Aragonite	$CaOCO_2$	crystalline	N.Y.

ONE HUNDRED AND SIX SPECIES.

28. The minerals of the foregoing list were submitted to the action of the following reagents successively: (1) A solution of citric acid saturated at the temperature of the laboratory, say 65° to 70° F.; this we call simply "citric acid." (2.) The same solution to which solid sodium (or potassium) nitrate is added, which for convenience we shall call the "nitro-citric mixture." (3.) The same solution to which solid potassium iodide is added at the time of testing, and which for simplicity we shall designate as the "iodo-citric mixture."

The action of these reagents was studied in the simple manner detailed in our first paper. The mineral to be examined was carefully freed from its associated gangue and finely pulverised in an agate mortar; a portion was placed in a test-tube, the solution of the acid was added, and the resulting phenomena, in the cold, and on boiling carefully noted. In many instances the partial decomposition of the mineral was ascertained by filtering from the residue, and testing the solution with an appropriate reagent; or by examining the disengaged gas with a suitable test-paper.

Sulphides, Arsenides, &c.

29. Minerals of this group treated with citric acid alone, yielded results as follows:—

(*a*.) Clausthalite and leucopyrite dissolve in the cold without liberation of gas.

(*b*.) Alabandite is very strongly attacked in the cold with evolution of sulphuretted hydrogen. On applying heat it is wholly soluble. In this respect alabandite appears to be the most easily decomposed of all the sulphides yet examined, 37 in number.

(*c*.) Boulangerite, jamesonite, and kermesite are more or less attacked by boiling citric acid, yielding sulphuretted hydrogen. The remaining minerals of this group resist the action of cold or hot citric acid. Sulphur is absolutely unattacked even when the citric acid solution is heated to the melting-point of the element.

The powerful solvent action of a mixture of citric acid and sodium nitrate was discussed in our first paper (19), here we need only add that the intensity of action claimed for it is fully maintained by later researches.

(*d*.) All the minerals of the first group, 25 in number, with three exceptions, dissolve in the nitro-citric mixture rapidly and completely, several of them yielding solutions of characteristic colour. Even sulphur itself is decidedly attacked, with formation of sulphuric acid. The exceptions are realgar, orpiment, and proustite.

(*e*.) Two of these, realgar and orpiment, are partially decomposed by boiling with the iodo-citric mix-

ture. Proustite and sulphur resist even on prolonged heating. All the remaining minerals of this group are quite readily dissolved, the decomposition of the sulphides being accompanied by liberation of sulphuretted hydrogen.

The differentiating power of these solvents is again exhibited by these reactions. In our first paper we showed that while bornite and pyrrhotite are decomposed by citric acid, their kindred compounds, chalcopyrite and pyrite, are not (13). We now find that proustite resists completely the decomposing solutions named, while pyrargyrite is decidedly attacked by the nitro-citric mixture as well as by the iodo-citric mixture, even in the cold.

This difference in behaviour of the two closely allied minerals was established by numerous determinations.

Oxides.

30. The oxides examined include such stable minerals as corundum, spinel, chrysoberyl, cassiterite, rutile, hyalite, and quartz, which naturally resist these methods of attack.

Gummite is attacked by cold citric acid, and melaconite and goethite are soluble to a certain extent on heating. Menaccanite and washingtonite are feebly attacked by the nitro-citric mixture and strongly by the iodo-citric solution. This latter also strongly attacks braunite and goethite.

Silicates.

31. Silicates are very unequally attacked by citric acid as well as by mineral acids.

(*a.*) Nephelite, lapis lazuli, laumontite, herschelite, thomsonite, mesolite, and prochlorite, are decomposed by citric acid in the cold, a portion of them with formation of a jelly.

Tephroite, ilvaite, gieseckite, jefferisite, heulandite, and genthite, are strongly attacked on boiling with the citric acid alone. Pargasite, pyrope, almandite, colophonite, phlogopite, bastite, masonite, and allanite (?), are feebly attacked. Some doubt obtains, however, as to the last named, because the specimens examined were partially decomposed on the surface.

(*b.*) The addition of sodium nitrate to the solution of citric acid does not notably increase its solvent power as respects silicates, but the addition of potassium iodide aids decidedly in effecting their decomposition. The iodo-citric mixture strongly attacks the garnets named, as well as enstatite, hypersthene, pargasite, epidote, and those named in paragraph 32.

The felspars resist these reagents, yet orthoclase and labradorite give up iron to them. Petalite, actinolite, asbestus, beryl, zircon, vesuvianite, zoisite, iolite, lepidolite, leucite, andalusite, fibrolite, topaz, titanite, staurolite, and kaolin, either wholly resist or give to the attacking solution only a trace of iron.

The variety of serpentine known as bowenite resists citric acid, while serpentine itself, of a normal character, is decomposed.

On the whole, citric acid attacks the silicates with a power nearly approaching that of hydrochloric acid.

Revision of the Silicates.

32. While carrying on these researches we were continually compelled to combat the firmly grounded impression that the organic acids are weak as respects mineral species. In consequence of this pre-conceived notion, we overlooked in our first paper the fact, that the decomposition of many silicates takes place at ordinary temperatures, having in fact applied heat at once when conducting the examination.

A closer investigation, however, shows that a saturated solution of citric acid is able to decompose many silicates in the cold, even to the formation of gelatinous silica. This necessitated a revision of the silicates named in our first paper (16), with the following results:—

(*a.*) Willemite, pectolite, calamine, natrolite, wollastonite, chrysolite, chondrodite, chrysocolla, apophyllite, rhodonite, analcite, chabazite, stilbite, and deweylite, are more or less strongly attacked by cold citric acid,—the first four yielding a jelly.

Datolite, prehnite, serpentine, chrysotile, and retinalite, are attacked on boiling the solution.

(*b.*) The use of the iodo-citric solution as a solvent having been discovered subsequent to the examination of the silicates named in our first paper, a further revision of this group became necessary. The results are briefly as follows:—

Olivine, augite, almandite, and epidote, heated with the iodo-citric mixture, are strongly attacked. Orthoclase, labradorite, hornblende, and spodumene, are very feebly attacked, or yield only iron to the solution.

Wernerite, albite, diopside, kyanite, talc, muscovite, biotite, ripidolite, and tourmaline, are not attacked.

These changes do not invalidate the accuracy of our published results, and are introduced simply to explain the change in position of these minerals in the Tables at the close of this paper.

(To be continued.)

SOLUTION OF BROMINE AS A REAGENT.

By L. L. DE KONINCK.

Bromine is more and more employed as an analytical reagent. Used alone it is not convenient, and a solution in water or in hydrochloric acid has been recommended. The former has the defect of being very dilute; the hydrochloric solution is much more concentrated but strongly acid. For three years the author has successfully used the solution of bromine in a 10 per cent solution of potassium bromide. The author recommends it for the precipitation of manganese from an acetic solution, for the conversion of arsenious into arsenic acid, and for the detection of nickel in presence of cobalt in a potassium cyanide solution.—*Zeitschrift für Analytische Chemie.*

NOTICES OF BOOKS.

A Popular History of Science. By R. Routledge, B.Sc F.G.S. London: G. Routledge and Sons.

The work before us can be fairly judged only on the conditions which the author has imposed upon himself. He has not undertaken the serious task of producing a history of science to serve as a book of reference for men of high attainments. He has not attempted to bring "into view those highly-generalised conceptions of modern thought with whose value and importance the expert is familiar." He has sought to furnish a book for popular use, and has accordingly introduced "simple illustrations of laws and principles, and ample details of experiments and observations" which a more learned class of readers would not require. The subjects treated of are astronomy, physics, chemistry, biology, and geology, and "to a certain small extent, mathematics." Psychology is not included. As a general rule Mr. Routledge observes the distinction between science and industrial art—so incomprehensible to the English national mind, and which even men of learning and high culture allow themselves to forget when they speak of noxious fumes and factory chimneys as "consequences of science." At times, however, the author loses sight of the boundary-line, as when he introduces accounts of the safety-lamp, the steam-engine, and the electric-telegraph.

In the earlier portions of the book the distinctions between the various branches of science are necessarily not observed. The author treats in successive chapters of ancient, Alexandrian, Arabian, and mediæval science. In the first of these sections he introduces accounts of Protagoras, Socrates, and Plato, whose claims to figure in a history of physical science are not unquestionable.

Full, but not exaggerated, honour is awarded to Roger Bacon. The fourth chapter is devoted to the science of the 16th century, the names of Copernicus, Tycho, Kepler, Gilbert, and Palissy, being the most prominent. The fifth chapter treats exclusively of Galileo, who persecutions and sufferings are described at length. The sixth section contains an account of the life and writings of Francis Bacon, of whose philosophy and its influence the author gives a very fair account, pointing out, however, the inconsistency of the "reformer of science," who could reject Copernicus and despise Gilbert. With the 17th century the sciences become differentiated, and we find mathematics, astronomy, physics, chemistry, and biology discussed henceforth in distinct chapters. To assign a fair proportion of so limited a space to each section of so vast a subject is, of course, a very difficult task. Perhaps it may be said that biology has scarcely fared as well at the author's hands as have the inorganic sciences. Thus, in the nineteenth century, physics receive 143 pages, whilst biology, at this epoch of evolution, is compressed into twelve.

The concluding remarks on the speculative aspects of modern science, on the conservation of energy and the dynamical view of the universe are deserving of warm commendation as a clear and luminous exposition. Within the boundaries which he has selected, Mr. Routledge may be pronounced a safe and judicious guide, and his work is admirably suited for well-educated young persons.

The illustrations are numerous, some, like the portrait of Faraday, characteristic and exceedingly appropriate; others of doubtful relevance.

CORRESPONDENCE.

COMMERCIAL ANALYSES.

To the Editor of the Chemical News.

Sir,—Mr. John Hughes has done good service in calling the attention of chemists to the discrepancies which arise in shoddy analyses owing to neglect of the loss of moisture which occurs in the preparation of samples for analysis. It is necessary, for a satisfactory nitrogen combustion, that the shoddy should be very finely cut up, and in a wet sample, as Mr. Hughes points out, the loss of water during this process is such as to cause a very serious error in analysis, unless it be estimated and taken into account. For a considerable time past it has been my own practice in analysis of damp shoddies to at once determine the water in the coarse sample as received and to dry the portion taken for analysis, so that the result when calculated out will give the true percentage of nitrogen and its ammonia equivalent in the sample as received. The same principle applies to other rough samples besides shoddy—raw phosphates for instance—and it is unfortunate that many analysts appear to pay no attention at all to the loss that takes place in grinding up such samples. A few days since, for example, I found that a sample of bone-ash, weighing but a few ounces, and containing in its coarse state as received about 12 per cent of moisture, lost during the process of grinding for analysis nearly 2 per cent of moisture, although the operation was performed as speedily as possible. The results were, of course, rendered on the original sample; but there are too many chemists who in such a case simply grind up the material and assume the fine portion to represent the original sample. An obvious injustice arises, seeing that commercial transactions in such materials are based altogether upon analytical results. It has during the last few years become the custom in most phosphate contracts to send the chemist a coarse sample for moisture only, and also a finely ground sample for analysis, the latter analysis being stated in the certificate, and a correction made to show the diminished percentage of phosphate which would accordingly be contained in the accompanying wet coarse sample. The analyst should work on preciseiy the same principle when he gets but the one coarse sample, otherwise his moisture—which is too often not determined at all—is too low and his phosphate too high. This precaution is particularly necessary in the case of bone-ash samples and similarly porous materials, which are capable of absorbing a good deal of water without appearing particularly damp, and which at the same time rapidly lose moisture during grinding in a mortar.

Perhaps such common-sense matters ought not to need ventilation in the pages of a scientific periodical; but trivial as they may be in one sense, they are of very serious importance to merchants, brokers, and manufacturers, and by no means of least importance to the large body of chemists—both chemists in factories and chemists in public practice—who occupy a high position of moral responsibility, affecting not only their own reputation, but the pockets of their clients or their employers.

I would take this opportunity of suggesting that the Institute of Chemistry—which has been, one way and another, a good deal occupied with the consideration of what may be called "chemical ethics"—should devote an evening to discussing not only the above points, but also sundry others which are frequently cropping up in the experience of commercial chemists, and which lie at the root of not a few of the too frequently recurring discrepancies that reflect so unpleasantly on the skill and practice of those whose occupation is assumed to be one of science and accuracy, and not one of rough and ready empiricism, as one might suppose from an occasional glance at some certificates which find their way into commercial transactions.—I am, &c.,

Bernard Dyer, F.C.S., F.I.C.

Analytical Laboratory, 17, Great Tower St., E.C,
January 11, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 24, December 13, 1880.

Reclamation of Priority as Regards the Law of the Corresponding Temperatures of Ebullition. — U. Dühring.—On February 23 last M. P. de Mondesir presented to the Academy a memoir on the comparison among the tension-curves of saturated vapours, and proposed a law identical with one put forward by M. Dühring nearly two years ago.

On Radiophony.—E. Mercadier.—The author has succeeded in proving that radiophonic effects may be produced by sources whose luminous brightness is much more feeble than that of an ordinary gas-light, and even by invisible radiations which are merely thermic.

New and Economical Methods for Producing Intermittent Luminous Signals.—E. Mercadier.—The author has devised a lamp where oxygen can be suddenly liberated in the midst of the flame, and as suddenly shut off, thus producing an intermittent flash for lighthouses, optical telegraphy, &c.

Absorption-Spectrum of Ozone.—J. Chappuis.—The absorption-spectrum of oxygen ozonised by the electric spark, if observed by means of a spectroscope with one or two prisms, presents eleven dim but well-defined bands in the portion of the spectrum ordinarily visible. The author has drawn up a diagram of these bands and compared it with the maps of the telluric bands. He notices the correspondence of a band in the orange with Angströms ray *a*, the origin of which he thinks must be sought in some other substance than watery vapour. On Angström's plan of the atmospheric rays there is laid down between the rays D and *a* a band extending from 606 to 613, a part of which coincides with the broadest band due to ozone. Angström mentions also in the yellow, towards D, an absorption-band always visible in the spectrum of the clear sky, and which extends from 568 to 58·12, and which he designates as *δ*. In the same region is a band due to ozone, and occupying a position partly in common with this band *δ*. The relative stability of ozone at low pressures and temperatures, and its almost incessant production by electric discharges render it an important element in the upper regions of the atmosphere, where its blue colour certainly takes a share in the colouration of the sky.

Action of Hydrochloric Acid upon Metallic Chlorides.—A. Ditté.—The chlorides which are rendered more soluble by hydrochloric acid are divided into two groups; the one (*e.g.*, mercuric chloride) exceedingly soluble in the concentrated acid form with it crystalline compounds; the other (*e.g.*, silver chloride) very sparingly soluble, even when heated, yield on cooling the chloride considered as anhydrous. The study of the chlorides which are precipitated from their solutions by hydrochloric acid will form the subject of a future communication.

Action of Hydrofluoric Acid upon Ammonium Bichromate.—L. Varenne.—The author has obtained by this reaction well-defined crystals of the formula—

$$NH_4F,2CrO_3.$$

Chlorine Derivatives of Strychnine.—MM. Richet and Bouchardat.—The authors have isolated in a state of purity three distinct chlorine compounds which preserve in different degrees the chemical properties of strychnine, especially of fixing the elements of water under the action of alkalies, and furnishing compounds which approach the amides by their general properties.

The Cause of Spontaneous Decomposition of Raw Cane-Sugar.—U. Gayon.—Organisms contained in these sugars multiply and produce an inversive ferment.

No. 25, December 20, 1880.

This issue consists merely of the discourses delivered at the funeral of the eminent mathematician, M. Michel Chasles, the *doyen* of the Section of Geometry.

Biedermann's Central-Blatt für Agrikultur-Chemie, Heft 6, 1880.

This issue opens with a biographical notice of the late editor, Dr. Richard Biedermann.

Researches on the Influence of Vegetation and its Shade upon the Carbonic Acid of the Ground-Air.—Prof. E. Woolny.—During the warm season soil overshadowed by living plants contained considerably smaller quantities of carbonic acid than such as was left fallow or covered with dead vegetation. The soil under a cover of growing plants is the poorer in carbonic acid the denser the vegetation.

The Permeability of Moss Coverings and Forest Refuse for Rain-water.—Dr. W. Riegler.—The conditions are too various to permit any decisive result.

Most Suitable Application of Artificial Manures for Potatoes.—Prof. M. Märker.—Not suitable for abstraction.

Signification of Lime for the Animal Organism.—Dr. E. Voit and Dr. F. Tuczek.—Animals deprived of lime in their food displayed in their bones modifications characteristic of rachitis.

Digestibility and Nutritive Value of Acorns.—Dr. H. Weiske, G. Kennepohl, and B. Schulze.—Acorns on account of their poverty in albuminoid matter can only be added in small proportions to the food of cattle.

Methods of Removing the Bitterness of Lupins.—Dr. E. Wildt.—The most satisfactory process is lixiviation with dilute sulphuric or hydrochloric acid.

Contributions to the Cultivation of the Sugar-Beet.—L. Vilmarin.—Deep ploughing and close planting are recommended to increase the yield of sugar.

Loss of Dry Matter during the Ripening of Crops.—MM. Marié Davy, A. Lévy, J. Roulff, and P. Dehérain.—During ripening there is often a considerable loss both of the nitrogenous and mineral constituents. It is not known whether this loss is necessary, nor if it can be avoided.

Researchea on the Growth of Leguminous Plants.—Dr. R. Pott.—Not adapted for abstraction.

Determination of the Proportion of Albuminoid Matter in Hay, &c.—Dr. H. P. Armsby.—The methods of Church (4 per cent solution of carbolic acid), Sestini (lead acetate), and Ritthausen (copper sulphate) give practically the same results as extraction with water.

The Albuminoids of Oil-seeds.—H. Ritthausen.—Albuminoid bodies containing more than 18 per cent of nitrogen, and closely resembling the conglutin of lupins and almonds are widely present in oil-seeds. Small quantities of nitrogen are present in non-albuminous compounds.

Connection of the Specific Gravity of Potatoes with their Proportion of Starch and of Dry Matter, and the Determination of Starch in Potatoes.—Prof. B. Tollens and Dr. J. Moritz.—The method described is pronounced inaccurate, admitting errors of from 1 to 2 per cent on either side of the correct quantity.

Chemical Change of Starch on Exposure to Steam at a High Pressure.—Dr. M. Stumpf.—A heat of 140° to 150°, and consequent pressure of 3½ to 4½ atmospheres convert 71 per cent of starch into glucose. The author considers that with the aid of 1 to 2 parts of acid per thousand saccharification may be carried so far as to render the use of malt unnecessary.

Contributions to the History of Starch and its Transmutations.—H. T. Brown and J. Heron.—From the *Annalen der Chemie*.

Experiments on the Production of Sugar from the Stems of Maize and Sorghum.—Prof. P. Collier.—The results are given in the form of tables.

Influence of Gypsum in the Manufacture of Sugar.—Dr. A. v. Wachtel.—The author found impurities of potassium and sodium sulphate in sugars prepared with gypsiferous water.

New Studies on the Part Played by Bone-black in the Sugar Manufacture.—H. Pellet.—Free lime is almost entirely absorbed by bone-black. Salts of lime and potash are also absorbed to a certain extent. Potash and lime, the latter in saline form, promote each others' absorption.

Action of Caustic Lime upon Pure Solutions of Sugar and Raw Beet-juice.—F. Desor.—If free alkalies or alkaline earths are added to a solution of sugar the rotation which sugar occasions in polarised light decreases, and is restored on neutralising the alkaline liquid with acetic acid.

Determination of the Absolute Quantity of Juice and of the Chemical Constituents of the Sugar Beet.—A. Gawalowski.—An extension of Grouven-Stammer's method.

The Analysis of Milk.—E. Marchand.—The author considers that in determining the total solids of milk the heat should not exceed 98° to 100°. He rejects the determination of fat by drying up with pumice, sand, &c., and extraction with ether. He prefers to mix the milk with twice its volume of a solution of equal parts water and glacial acetic acid, which completely dissolves the caseine. The fat globules are filtered off, and dissolved out of the filter with ether. Or he renders the milk alkaline, agitates with ether, and obtains the fat by distilling the ethereal solution.

Influence of the Method of Sampling Milk.—C. Weikowitsch and Dr. v. Klenze.—The authors consider it necessary to stir up a bowl of milk thoroughly immediately before taking the sample. An inverted beaker is then plunged into the milk up to its middle, inverted, and immediately drawn out in an upright position.

Sophistications of Commercial Melted Butter.—Dr. E. Meissl.—The butter in question is such as has been melted before sale. The author proceeds on Reichert's method, which he has somewhat modified.

A Section on Fermentation, Putrefaction, and Decay contains papers on the chemical changes of potatoes on freezing and putrefying, by H. Czubata; a memoir by Dr. Heinzelmann, on grain used in the manufacture of cake-yeast; an account of experiments with different kinds of yeast in mashing treacle for distillation, by A. Riche; and a note by E. C. Hansen on the influence of ventilation on the fermentation of worts.

Reimann's Färber Zeitung,
No. 31, 1880.

This number is largely taken up with the Leipzig Exhibition, and with a criticism of the new railway regulations concerning the transit of chemicals.

No. 32, 1880.

Artificial Indigo.—Prof. Baeyer has discovered a new blue colouring matter of the indigo-group. It is obtained by the prolonged contact of nitro-cinnamic and sulphuric acids.

No. 33, 1880.

Salicylic Acid in Textile Manufactures.—Dr. F. von Heydon recommends salicylic acid to be applied in dilute solution to woollen yarns, and to be mixed with sizes to prevent mildew, unpleasant smells, &c. Five grms. acid are sufficient for a litre of size.

Solution of Starch.—Zulkowsky proposes to make starch perfectly soluble in water by heating it to 190° C. along with glycerine. This process is most successful with potato-starch, less so with wheat-starch, and very difficult with rice-starch.

No. 34, 1880.

Electric Light in Manufacturing Establishments.—The River Side spinning mills in Providence, New Jersey, are now lighted with 71 lamps on Edison's system, which dispense with 578 gas-burners. The gas-consumption used to cost 6½ dollars per hour, while the 71 electric lights do not cost quite 2½ dollars hourly. The annual saving amounts to 12,000 dollars. The Spindler Works at Köpenick use the Jablochkoff candles, which give a light tinged with violet.

No. 35, 1880.

New Colouring Matters.—A Frankfort firm have latterly introduced several new colours into the market. Among these are Imperial Green (Kaiser Grün), "Vat Blue W," "Marine Blue," and "Gensdarm Blue." The last mentioned colour is mixed with an equal weight of acetic acid at 7° B., and added to abundance of hot water, brought nearly up to the boiling with frequent stirring, filtered, and used as hot as possible. Wool is dyed without any mordant entering at 62° and raising gradually to 100°. An addition of more acetic acid gives a greener shade, which may be pushed still further by the addition of Imperial Green. The admixture of Marine Blue R give redder tones. If carefully dyed this colour does not smear off. "New Marine Blue" is dissolved in the same manner. Wool is entered in the cold, heated gradually to 100° and requires no mordant. If bluer tones are required more acetic acid or Gensdarm Blue is added. "New Grey" is also used without mordant, raising the beck from 60° to 75°. It is modulated to a blue with acetic acid, to a red with cerise, and to a yellow with "mode." It is expected that chryso-toluidin (phosphine) will be entirely superseded by chrysoidine.

No. 36, 1880.

This number contains nothing of general interest.

MISCELLANEOUS.

Society of Arts.—A paper on "A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda" is announced for reading before this Society on Thursday evening, the 27th inst., by Mr. James Mactear, F.C.S., of Glasgow.

Presentation to Mr. Norman Tate, F.C.S., F.I.C.—We learn with great pleasure that on the 7th inst., a tea and coffee service of solid silver was presented to the above gentleman in recognition of his long and able services as a teacher of science in Liverpool. The presentation took place in the Town Hall, and was performed by the Mayor. Among the subscribers to the testimonial are included the three members for the city, many of the Aldermen, leading merchants, manufacturers, and professional men. Mr. Tate in returning thanks, referred to the gratifying fact that whereas the attendance at the Liverpool Science Classes had been at first only 20, the entries had this year reached 770.

The Reducing Agent in Urine containing Benzoic Acid.—E. Salkowski.—The reducing substance is an acid which has not yet been obtained in a crystalline condition. —*Z. f. Phys. Chem.*, 4, 135.

MEETINGS FOR THE WEEK.

MONDAY, 24th.—London Institution, 5.
—— Medical, 8.30.

TUESDAY, 25th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.

WEDNESDAY, 26th.—Society of Arts, 8. "Suggestions for Preventing London Smoke," W. D. Scott-Moncrieff.

THURSDAY, 27th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda," James Mactear, F.C.S.
—— Royal Institution, 3. "The Troubadours," Mr. F. Huefler.

FRIDAY, 28th.—Royal Institution, 8. "Modern Spectroscopy," Dr. Schuster, 9.
—— Quekett, 8.

SATURDAY, 29th.—Royal Institution, 3. "The Amazons," Prof. S. Colvin.

TO CORRESPONDENTS.

E. H.—We only know of a very small one by Feller, in two volumes, published by Trübner.

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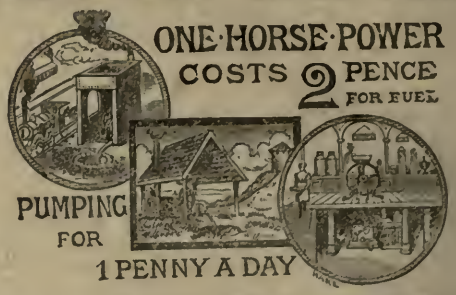

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THE CHEMICAL NEWS.

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ON THE

ULTIMATE ANALYSIS OF ORGANIC SALTS OF THE ALKALIES AND ALKALINE EARTHS.

By H. SCHWARTZ and P. PASTROVICH.

THE ultimate analysis of organic salts of the alkalies and alkaline earths is now generally performed by means of chromate of lead, which is more costly than copper oxide, as it cannot be regenerated, and as it admits of only one use of a combustion-tube. It has been proposed to add pure fused potassium dichromate to the substance in the boat, and placing granulated copper oxide before it. Accurate determinations of carbon have been obtained in this manner, but a simultaneous estimation of the mineral constituent has to be dispensed with. If, however, as is now very general, the combustion is performed in a current of oxygen, the following method appears useful:—We prepare pure mercury chromate by precipitating pure neutral potassium chromate with mercurous nitrate, and washing by decantation. It is dried and ignited in a porcelain capsule, leaving pure finely-divided chromic oxide. An excess of this is thoroughly mixed with the weighed organic salt, and placed in a platinum or porcelain boat, not too small. The combustion-tube is open at both ends, and filled for two-thirds of its length with granular copper oxide, and ignited in a current of dry air. The charged boat is then introduced at the back, and the combustion is completed in the well-known manner. Pure dry oxygen is finally passed through for a sufficient time, whereby the carbonates of the alkalies and alkaline earths are entirely converted into neutral chromates, and the whole of the carbonic acid is obtained. Even nitrogenous substances may thus be burnt without danger of the formation of nitrogen oxides if the current of oxygen is kept moderate at the outset, so that the metallic copper placed in front may remain unoxidised till the last. If the boat is carefully drawn out when cold the base present in the salts may be accurately found by determining the chromates. In case of the soluble alkaline chromates this is performed most simply by means of a decinormal lead solution, which is run into the aqueous solution of the contents of the boat till a drop no longer gives a red precipitate with silver nitrate. In case of the chromates of the alkaline earths, it is more convenient to mix the contents of the boat with an excess of an acid solution of ferrous chloride of known strength, and to titrate the not-oxidised ferrous salt in the filtrate with permanganate.

In case of explosive nitro-products, such as potassium picrate, it is necessary to mix the substance first with chromic oxide, and then with an excess of copper oxide. The separation of the chromate formed from the copper oxide presents no difficulty. The same method may be adopted in the analysis of carbonates.—*Berichte der Deutschen Chemischen Gesellschaft.*

M. WIEDEMANN'S ELECTRIC PAPER.

ORDINARY letter-paper, if well heated and briskly rubbed with the hand or with a brush, acquires electric properties; it adheres to tables, walls, &c., and on contact with the hand it gives slight electric discharges, visible in the dark. But on taking Swedish filter-paper, and submitting it to the treatment described below, its electric properties are greatly intensified, and sparks may be drawn from it several centimetres in length. The paper is steeped in a mixture of equal volumes of nitric and sulphuric acid, as in the manufacture of gun-cotton. The paper thus pyroxilised is washed with abundance of water and dried. If laid on a sheet of waxed paper and rubbed briskly it manifests energetic action, and may be used for the repetition of almost all experiments in static electricity.—*Comptes Rendus.*.

ON THE

APPLICATION OF ORGANIC ACIDS TO THE EXAMINATION OF MINERALS.*

(SECOND PAPER.)

By H. CARRINGTON BOLTON, Ph.D.

(Concluded from p. 34).

Sundry Minerals.

33. UNDER this head are grouped phosphates, arseniates, tungstates, sulphates, &c., as stated in the list given in 27.

A large number, chiefly phosphates, dissolve easily in a cold solution of citric acid; these embrace the following:—

Mimetite, triphylite, triplite, libethenite, olivenite, atacamite, pseudomalachite, wavellite, pharmacosiderite, torbernite, autunite, ulexite, cryptomorphite, and brochantite. Wulfenite and crocoite are strongly attacked on boiling, the latter yielding a green solution, owing to the reducing action of the organic acid on the chromic acid.

Columbite and wolframite are attacked by the iodo-citric mixture, at least so far as partially to dissolve the iron which forms one of their constituents.

Hübnerite is attacked by the nitro-citric mixture; while scheelite, barite, celestite, anhydrite, and graphite, resist completely these methods of attack.

Native Elements.—In our first paper we called attention to the solvent power of the nitro-citric mixture, as shown by the fact that it dissolves metallic copper, silver, lead, tin, bismuth, and antimony, besides iron, zinc, and magnesium (20); to this list we now add arsenicum and mercury.

Tabulation of Results.

34. In paragraph 22 we gave a table showing the behaviour of ninety minerals with citric acid and other reagents, arranged under eleven heads, viz.:—

A. Minerals which dissolve in cold citric acid without evolution of gas.

B. Minerals which dissolve in cold citric acid with liberation of carbonic anhydride.

C. Minerals which are decomposed by cold citric acid with evolution of sulphuretted hydrogen.

D. Minerals which dissolve in hot citric acid without evolution of gas.

E. Minerals which dissolve in hot citric acid with liberation of carbonic anhydride.

F. Minerals which are decomposed by hot citric acid with evolution of sulphuretted hydrogen.

G. Minerals which are decomposed by hot citric acid with formation of gelatinous silica.

H. Minerals which are decomposed by hot citric acid with separation of slimy silica.

I. Minerals decomposed by boiling with citric acid and sodium nitrate.

K. Minerals decomposed by heating with citric acid and ammonium fluoride.

L. Minerals which are not attacked by any of these methods.

To this we added, in a subsequent paper, a twelfth group, viz.:—

M. Minerals decomposed by heating with citric acid and potassium iodide.

* Read before the New York Academy of Sciences and the Chemical Section of the British Association, Swansea Meeting, 1880.

TABLES SHOWING THE BEHAVIOUR OF CERTAIN MINERALS WITH CITRIC ACID, ALONE AND WITH REAGENTS.

I.

DECOMPOSED (IN FINE POWDER) BY A SATURATED SOLUTION OF CITRIC ACID.

1.—*In the Cold.*

A. Without Evolution of Gas.	B. With Liberation of CO_2.	C. With Liberation of H_2S.	D. With Separation of SiO_2.
Clausthalite	Calcite !	Stibnite	Wollastonite
Leucopyrite	Dolomite*	Galenite	Rhodonite !
Atacamite	Gurhofite !	Alabandite	Chrysolite
Brucite	Ankerite*	Sphalerite	Willemite !‡
Gummite	Rhodochrosite*	Pyrrhotite	Nephelite
Pyromorphite*	Smithsonite*		Lapis lazuli
Mimetite	Aragonite !		Chondrodite
Triphylite	Witherite !		Pectolite !‡
Triplite	Strontianite !		Laumontite !‡
Vivianite !	Barytocalcite !		Chrysocolla !
Libethenite !	Cerussite !		Calamine !‡
Olivenite !	Malachite !		Apophyllite
Pseudomalachite	Azurite*		Thomsonite !
Wavellite			Natrolite !‡
Pharmacosiderite !			Mesolite !
Torbernite			Analcite
Autunite			Chabazite
Ulexite !			Herschelite‡
Cryptomorphite !			Stilbite
Anglesite			Deweylite
Brochantite !			Prochlorite

2.—*On Boiling.*

E. Without Evolution of Gas.	F. With Liberation of CO_2.	G. With Liberation of H_2S.	H. With Separation of SiO_2.
Cuprite !	Hausmannite†	Bornite	Tephroite‡
Zincite	Pyrolusite !†	Jamesonite*	Ilvaite
Melaconite	Manganite†	Bournonite	Phlogopite*
Goethite*	Psilomelane !†	Boulangerite	Datolite !‡
Limonite*	Wad !†	Kermesite	Prehnite*
Allanite (?)	Magnesite !		Heulandite
Apatite*	Siderite !		Serpentine
Wolframite*			Chrysotile
Wulfenite			Retinalite
Crocoite			Bastite
Gypsum			Genthite
			Gieseckite*
			Jefferisite
			Masonite*
and those in A.	*and those in B.*	*and those in C.*	*and those in D.*

II.

DECOMPOSED BY A BOILING SOLUTION OF CITRIC ACID, MIXED—

I.—With Sodium Nitrate.		K.—With Potassium Iodide.	
Silver	Cobaltite !	Realgar*	Almandite
Mercury	Ullmannite !	Orpiment*	Pyrope
Copper	Marcasite !	Cinnabar !	Colophonite
Arsenic	Arsenopyrite !	Hematite*	Epidote
Antimony	Nagyagite	Menaccanite*	
Bismuth	Covellite !	Washingtonite*	
Sulphur*	Berthierite !	Magnetite*	
Bismuthinite	Pyrargyrite	Franklinite	
Domeykite !	Tetrahedrite !	Braunite	
Argentite	Tennantite !	Enstatite	
Hessite	Stephanite	Hypersthene	
Chalcocite !	Polybasite !	Augite	
Tiemannite !	Enargite !	Spodumene*	
Millerite !	Uraninite !	Hornblende*	
Niccolite !	Hübernite	Actinolite*	
Pyrite !		Pargasite*	
Chalcopyrite !		Olivine	*and most of those in A, B, C, D, E, F, G, H, and I.*
Linnæite			
Smaltite !	*and those in C and G.*		

III.

Minerals not Decomposed by the above Reagents.

Graphite	Iolite	Talc	Labradorite
Molybdenite	Biotite	Kaolin	Oligoclase
Proustite	Muscovite	Ripidolite	Albite
Fluorite	Lepidolite	Columbite	Orthoclase
Cryolite	Wernerite	Samarskite	Tourmaline
Corundum	Leucite	Spinel	Scheelite
Diopside	Andalusite	Chromite	Barite
Petallite	Fibrolite	Chrysoberyl	Celestite
Asbestus	Kyanite	Cassiterite	Anhydrite
Beryl	Topaz	Rutile	
Zircon	Titanite	Quartz	(Two hundred species.)
Vesuvianite	Staurolite	Hyalite	
Zoisite	Bowenite	Anorthite	

N.B.—The gases evolved are examined with acetate of lead test-paper, the solutions with appropriate reagents.

The kind and degree of action are indicated in the above Tables by the following signs:—! Completely decomposed or dissolved. * Feebly attacked. † The CO_2 evolved is derived from the citric acid. ‡ Gelatinises.

In the Tables accompanying this paper we have combined, on a similar plan, the results obtained in the present and previous communications, thus giving a comprehensive view of the behaviour of two hundred minerals with citric acid. The arrangement differs somewhat from the foregoing; we have re-adjusted the silicates to accord with facts stated in 32, and we have omitted the reaction with ammonium fluoride as of no importance in determining species.

To ascertain the exact position for each mineral has been no trivial task; and should errors be discovered, we crave indulgence, and beg our friends to remember the French saying: "Ceux qui ne se trompent jamais sont ceux qui ne font rien."

Summary.

35. The number of minerals examined, though considerable, if we regard the labour involved, is but small compared with those which remain to be treated by these methods, and any attempt at generalisation must be correspondingly weak.

It may, however, be admissible to study the Tables with a view to determining whether there is any relation, peculiar to the organic acid, between its solvent power and the chemical constitution of the minerals. This question may be considered from two standpoints, corresponding to two methods of classifying minerals, viz., with reference to their acidic and to their basic constituents.

(*a*.) The first method of grouping the minerals is the same as that of the list given (27); the question applied to them may be answered thus:—

All carbonates and phosphates are decomposed by citric acid.

The sulphides are very unequally attacked;—two resist the solvents, three yield only to the iodo-citric mixture, twenty-two only to the nitro-citric mixture, and ten are attacked by the acid alone. The oxides and anhydrous silicates are very unequally attacked.

The hydrous silicates are (with one or two exceptions) decomposed by citric acid alone.

(*b*.) An examination of the influence of the basic constituents on the solubility discloses the following points:—

All the copper minerals are soluble in one or more of the solvents.

All the manganese minerals are decomposed,—the sulphide and the silicates with great facility.

All the lead minerals are decomposed by citric acid alone. In some cases the presence of lead would seem to render a mineral easily broken up; this is marked in the case of the sulphides, which, as we have seen, are very unequally attacked; thus selenide of lead is attacked and selenide of mercury is not; sulphide of lead is attacked, while sulphide of silver is not. The minerals jamesonite, bournonite, and boulangerite (containing lead) are attacked, while the closely allied species stephanite, tennantite, polybasite, proustite, berthierite, &c. (devoid of lead) are not decomposed.

These facts may possibly point to a connection between chemical constitution and solubility, peculiar to the reagent employed; but we offer the suggestion with diffidence, owing to the limited number of facts on which to base generalisations. Moreover we find that the results obtained by the *prolonged* action of citric acid on minerals (ten to thirty days), differ greatly from those here recorded. To this we shall return at a subsequent period.

In conclusion, we beg leave to remind our readers that the immediate object in view, as was stated at length in our first paper, is the practical application of these methods to the examination of minerals in the field.

Trinity College, Hartford, Conn.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 20th, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—F. N. Benjamin, J. J. Eastick, C. A. McMunn, W. G. McMillan, Tozokichi Takamatsu, P. Vieth.

The President then announced that the Faraday Lecture would be delivered by Prof. Helmholtz, on April 5, at the Royal Institution. The subject of the lecture would be "The Modern Development of Faraday's Conception of Electricity."

The President then called on Mr. Vivian Lewes to read a paper on "*Penta-thionic Acid.*" In March last the author, at the suggestion of Dr. Debus, undertook an investigation of penta-thionic acid, the existence of which has been denied. The analyses of the liquid obtained by Wackenroder and others, by passing sulphuretted hydrogen and sulphur dioxide through water, are based on the assumption that only one acid is present in the solution, and consequently do not establish the existence of penta-thionic acid; as, for example, a mixture of one molecule of $H_2S_4O_6$ and one molecule of $H_2S_6O_6$ would give the same analytical results as $H_2S_5O_6$. Moreover, no salt of penta-thionic acid has been prepared in a pure state. The author has succeeded in preparing barium penta-thionate thus:—A Wackenroder solution was about half-neutralised with barium hydrate, filtered, and the clear solution eva-

porated *in vacuo* over sulphuric acid. After eighteen days crystals, which proved to be barium penta-thionate + 3 molecules of water, formed. These crystals were separated, and the liquid further evaporated, when a second crop was obtained, intermediate in composition between the tetra- and penta-thionate. These were separated, and the mother-liquor on standing deposited some oblong rectangular crystals. These on analysis proved to consist of baric penta-thionate with three molecules of water. This salt dissolves readily in cold water; the solution is decomposed by strong potassic hydrate, baric sulphite, hyposulphites, and sulphur being formed. By a similar method of procedure the author obtained potassium penta-thionate, anhydrous and with 1 or 2 molecules of water. The author promises some further results with some other salts of the higher thionates.

The PRESIDENT said that the Society had to thank the author for a very complete research on the subject of penta-thionic acid. He, however, begged to differ from him as to his statements concerning the researches of Messrs. Takamatsu and Smith: in his opinion these authors had proved the existence of penta-thionic acid. He hoped that the crystals (which were very fine) would be measured.

Dr. DEBUS said that no one had previously been able to make the salts of penta-thionic acid, and expressed his sense of the great merit due to the author for his perseverance and success. The paper opened up some highly interesting theoretical speculations as to the existence of hexa-thionic acid. If potassium tetra-thionate was dissolved in water it could be re-crystallised, but potassium penta-thionate, under similar circumstances, splits into sulphur and tetra-thionate; but a mixture of tetra-thionate and penta-thionate can be re-crystallised. It seemed as if the sulphur when eliminated from the penta-thionate combined with the tetra-thionate.

Dr. DUPRÉ asked Dr. Debus how it was that a molecule of penta-thionate could be re-crystallised, whereas two molecules of penta-thionate, which should when half-decomposed furnish a molecule of tetra- and a molecule of penta-thionate, could not.

Dr. ARMSTRONG then read a "*Preliminary Note on some Hydrocarbons from Rosin Spirit.*" After giving an account of our knowledge of rosin spirit, the author decribed the result of the examination of the mixture of hydrocarbons remaining after heating it with sulphuric acid and diluting with half its volume of water and steam distilling. Thus treated rosin spirit furnishes about one-fourth of its volume of a colourless mobile liquid, which after long-continued fractional distillation is resolved into a variety of fractions boiling at temperatures from 95° to over 180°. Each of the fractions was treated with concentrated sulphuric acid, and the undissolved portions were then re-fractionated. The hydrocarbons dissolved by the acid were recovered by heating under pressure with hydrochloric acid. Besides a cymene and a toluene, which have already been shown to exist in rosin spirit, meta-xylene was found to be present. The hydrocarbons insoluble in sulphuric acid are, apparently, all members of the C_nH_{2n} series; they are not, however, true homologues of ethylene, but hexhydrides of hydrocarbons of the benzene series. Hexhydro-toluene and probably hexhydro-meta-xylelene are present besides the hydrocarbon $C_{10}H_2O$, but it is doubtful if an intermediate term is also present. It is by no means improbable, however, that these hydrocarbons are, at least in part, products of the action of the sulphuric acid. Cahours and Kraemer's and Godzki's observations on the higher fractions of crude wood spirit, in fact, furnish a precedent for this view. Referring to the results obtained by Anderson, Tilden, and Renard, the author suggests that rosin spirit perhaps contains hydrides intermediate in composition between those of the C_nH_{2n-6} and C_nH_{2n} series, also derived like the latter from hydrocarbons of the benzene series. Finally, Dr. Armstrong mentioned that the volatile portion of the distillate from the non-volatile product of the oxidation of oil of turpentine in moist air furnishes ordinary cymene when treated in the manner above described. The fact that rosin spirit yields a different cymene is, he considers, an argument against the view which has more than once been put forward, that rosin is directly derived from terpene. Probably resin and turpentine, though genetically related, are products of distinct processes.

The next paper was "*On the Determination of the Relative Weight of Single Molecules*," by E. VOGEL, of San Francisco. This paper, which was taken as read, consists of a lengthy theoretical disquisition, in which the author maintains the following propositions:—That the combining weights of all elements are one-third of their present values; the assumption that equal volumes of gases contain equal numbers of molecules does not hold good; that the present theory of valency is not supported by chemical facts and that its elimination would be no small gain for chemistry in freeing it of an element full of mystery, uncertainty, and complication; that the distinction between atoms and molecules will no longer be necessary; that the facts of specific heat do not lend any support to the theory of valency. The paper concludes as follows:—"The cause of chemical action is undoubtedly atmospheric pressure, which under ordinary conditions is equal to the weight of 76 cubic centimetres of mercury, one of which equals 6·145 mercury molecules, so that the whole pressure equals 467 mercury molecules. This force—which with regard to its chemical effect on molecules can be multiplied by means of heat—is amply sufficient to bring about the highest degree of molecular specific gravity by the reduction of the molecular volumes. To it all molecules are exposed and subjected unalterably, and if not accepted as the cause of chemical action, its influence has to be eliminated to allow the introduction and display of other forces."

The next communication was "*On the Synthetical Production of Ammonia by the Combination of Hydrogen and Nitrogen in Presence of Heated Spongy Platinum (Preliminary Notice)*," by G. S. JOHNSON. Some experiments, in which pure nitrogen was passed over heated copper containing occluded hydrogen, suggested to the author the possibility of the formation of ammonia: only minute traces were formed. On passing, however, a mixture of pure nitrogen (from ammonium nitrite) and hydrogen over spongy platinum at a low red heat, abundant evidence was obtained of the synthesis of ammonia. The gases were passed, before entering the tube containing the platinum, through a potash bulb containing Nessler reagent, which remained colourless. On the contrary, the gas issuing from the platinum rapidly turned Nessler reagent brown, and in a few minutes turned faintly acid litmus solution blue; the odour of NH_3 was also perceptible. In one experiment 0·0144 grm. of ammonia was formed in two hours and a half. The author promises further experiment as to the effect of temperature, rate of the gaseous current, and substitution of palladium for platinum. The author synthesised some ammonia before the Society with complete success.

The PRESIDENT referred to the synthesis of ammonia from its elements recently effected by Donkin, and remarked that apparently the ammonia was formed in much larger quantities by the process proposed by the author of the present paper.

Mr. WARINGTON suggested that some HCl gas should be simultaneously passed with the nitrogen and hydrogen, and that the temperature of the spongy platinum should be kept just below the temperature at which NH_3 dissociates, in order to improve the yield of NH_3.

"*On the Oxidation of Organic Matter in Water*," by A. DOWNES. The author considers that the mere presence of oxygen in contact with the organic matter has but little oxidising action unless lowly organisms, as bacteria, &c., be simultaneously present. Sunlight has apparently considerable effect in promoting the oxidation of organic

matter. The author quotes the following experiment:—A sample of river-water was filtered through paper. It required per 10,000 parts, 0·236 oxygen as permanganate. A second portion was placed in a flask plugged with cotton-wool, and exposed to sunlight for a week; it then required 0·200. A third portion after a week, but excluded from light, required 0·231. A fourth was boiled for five minutes, plugged, and then exposed to sunlight for a week; required 0·198. In a second experiment with well-water a similar result was obtained; more organic matter was oxidised when the organisms had been killed by the addition of sulphuric acid than when the original water was allowed to stand for an equal length of time. The author also discusses the statement made by Dr. Frankland that these is less ground for assuming that the organised and living matter of sewage is oxidised in a flow of 12 miles of a river than for assuming that dead organic matter is oxidised in a similar flow.

"*Analyses of Queensland Soils*," by Prof. LIVERSIDGE. These analyses are of interest, as the soils include samples from localities which were exempt from the disease which was prevalent in the sugar plantations around. Analyses of the organic and mineral constituents of the surface and sub-soils are given.

"*On the Volumes of some Compounds of the Benzene, Naphthalene, Anthracene, and Phenanthrene Series*," by W. RAMSAY. The author has determined the volume of a number of these substances in a perfectly pure state by the method given in *Chem. Soc. Jour.*, 1879. 473. The numbers are in every case smaller than those calculated. The mean of the differences in the benzene series is 3·92. The author has also determined the differences in the naphathalene and the anthracene series, and finds that there is a certain proportionality observable in the condensation of members of the benzene, naphthalene, and anthracene series.

"*On the Atomic Volume of Nitrogen*," by W. RAMSAY. The author discusses the very slender grounds on which the accepted value of nitrogen in the amines (2·3) rests. From experiments with aniline, toluidine, dimethyl-aniline he concludes the value of nitrogen to be about 0·7, a number which is more probably true, for several reasons discussed by the author.

"*On a New Theory of the Conversion of Bar-iron into Steel by the Cementation Process*," by R. S. MARSDEN. The explanation of this phenomenon is to be found in the diffusion of carbon in an impalpable powder into the heated iron. It is analogous to the penetration of a red-hot porcelain crucible by carbon in an impalpable powder observed by the author (*Proc. Roy. Soc. Edin.*, x., 712), the carbon diffusing into the bars of iron while in an expanded and softened state. Silicon can apparently diffuse in a similar way through iron.

"*On the Action of Sulphyrate of Potassium on Chloral Hydrate (Preliminary Note)*," by W. W. J. NICOL. The chloral hydrate was obtained from Kahlbaum. Some freshly prepared sulphydrate of potassium was placed in a flask, and some chloral hydrate added. At first the crystals dissolved quietly, then gas was evolved, and the solution became more coloured, and a light yellow flocculent body separated. When this body appeared equal in bulk to the liquid, the fluid was filtered, and the residue washed, and dried *in vacuo*. Bisulphide of carbon extracted from it 35 per cent of sulphur. The residue gave on analysis the formula $C_3H_4S_2O_4$, which agrees very closely with that of a mixture of thio-glyoxylic acid and thio-formic acid in molecular proportions. A lead and barium salt were obtained, containing respectively 54·5 per cent Pb and 43·2 per cent Ba.

The Society then adjourned to February 3, when the following papers will be read:—"On the Estimation of Organic Carbon in Air," by A. Dupré and H. W. Hake. "On the Action of the Copper-zinc Couple upon Nitrates," by M. W. Williams.

PHYSICAL SOCIETY.

Saturday, January 22, 1881.

Prof. W. G. ADAMS in the Chair.

NEW member—Mr. G. Palgrave Simpson, B.Sc.

"*Notes on the Construction of the Photophone*," by Prof. SYLVANUS THOMPSON were read by Prof. REINOLD. Prof. Thompson was led by experiment to question whether Prof. Bell's form of photophone receiver was adapted to give the best results. Theoretically he finds with a given maximum of incident light distributed uniformly over the surface, the change of resistance in a selenium receiver will vary proportionally with its linear dimensions provided its parts be arranged so that on whatever scale constructed the normal resistance shall remain the same. A cell n times greater linearly each way will produce n times the variation in resistance for the same total amount of light. This follows from Prof. W. G. Adams's law that the change in the resistance of selenium is directly as the square root of the illuminating power. The author also finds that if the thickness of the conducting discs in the enlarged cell be kept the same as before, and their number increased n times, the change of resistance will be n^2 times as great as before, as possible, and the light should be distributed over them uniformly, not focussed to a point. A conical mirror would therefore be better than a parabolic one to receive the beam. Such a reflector would be cheaper to construct, and there would be a minimum of loss by reflection, as the light would fall perpendicularly on a cylindrical cell parallel to its axis. To give the best effect its angular semi-aperture should be 45°, and this will bring the front end of the cell in the same plane as the mouth of the reflector. Prof. Thompson has also constructed an improved cell by winding parallel wires on a cylinder of slate grooved with a double-threaded screw, and filling the interval between them with selenium. This form gives superior effects to Prof. Bell's disc device.

Mr. SHELLFORD BIDWELL said that long annealing improved the sensitiveness of selenium for photophonic purposes. He got the best speech from cells of high total resistance made with fine wire. The selenium should, however, have a low specific resistance. With the apparatus he showed at a recent meeting of the Society he could now transmit articles from *Nature* and the *Nineteenth Century* so as to be heard every word by the listener.

Prof. GUTHRIE suggested that amorphous phosphorus should be tried in place of selenium, as a more permanent substance.

Mr. GLAZEBROOK, of the Cavendish Laboratory, Cambridge, read a paper on the measurement of small resistances, and the comparison of the capacities of two condensers. In measuring small resistances by the Wheatstone balance, the results differed on varying the resistance in the battery wires. According to Prof. Chrystal this was due to a thermo-electric effect produced by the hand at the middle point of the divided platinum-iridium wire when the contact is made with it. It could be avoided by making this contact first and then making the battery contact. Mr. Glazebrook investigated the effect mathematically and experimentally. He suggested that the resistance in the battery wire should be kept small in comparison with the other resistances, and then the effect was inappreciable. It could also be eliminated by taking two measurements with reversed currents and calculating out. The author next considered the effect of a small leakage in comparing condensers by the Wheatstone balance method. He showed that the method was more sensitive when the resistances of galvanometer and divided coil were large.

Dr. J. HOPKINSON stated that he had found a modification of this plan to be very promising. For the battery he uses an induction coil, and for the galvanometer a telephone. Thus a high electromotive force and sensibility was obtained.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Monday, December 6, 1880.

Mr. ALEXR. WHITELAW, F.C.S., Vice-President in the Chair.

FOUR gentlemen were elected associates of the Section.

The SECRETARY read a letter from Prof. Williamson, University College, London, intimating his willingnes to adjudicate in the Graham Medal competition.

Dr. WALLACE, President of the Philosophical Society, read a paper on "*The Chemistry of Sewage Precipitation*," which will appear in our next issue.

NOTICES OF BOOKS.

Lehrbuch der Organischen Qualitativen Analyse. (Text-book of Organic Qualitative Analysis.) By Dr. C. T. BARFOED. Copenhagen: A. F. Höst and Son.

A COMPLETE manual of proximate organic analysis, both qualitative and quantitative, is as yet a desideratum in the literature of chemistry. Whether such a work can ever be produced as satisfactory as are certain treatises on inorganic analysis is, perhaps, open to question. Organic compounds are not merely excessively numerous, even if we restrict our attention to such as are of technical or pharmaceutical importance, but their characteristic reactions are liable to be modified or masked by the presence of foreign bodies to a greater extent than is known to be the case with the metals and their derivatives, necessitating of course modified processes for their recognition and determination. We need here merely mention as an instance that the detection of aconitine by means of extraction with alcohol becomes impracticable if oil is simultaneously present. Nevertheless, if absolute completeness cannot be reached, there is hope of very great progress in that direction, and we accept Prof. Barfoed's work as a most useful contribution. The first part only of this treatise is in our hands, which deals with the natural organic acids, and enters upon the amylaceous group.

Turning, as an example, to oxalic acid, we find that the author describes the free acid, and states its solubility in water, alcohol, and ether. He notices the general character of the oxalates, the behaviour of the acid when heated alone, with excess of concentrated sulphuric acid, with dilute sulphuric acid and manganese peroxide, when treated in the cold with strongly dilute sulphuric acid and a drop of potassium permanganate. He mentions the reaction of the free acid and of soluble oxalates with barium chloride, calcium chloride or acetate, calcium sulphate, lime water, and solutions of ferrous oxide. He points out how this last-mentioned reaction is affected by the presence of tartaric, and especially of citric acid. We are told that in presence of such and similar acids the detection of oxalic acid may be very satisfactorily effected by means of copper sulphate, with the addition of a small quantity of hydrochloric or nitric acid, and subsequent dilution with water. We find next an account of the behaviour of oxalic acid with lead acetate and silver nitrate, followed by instructions for the recognition of oxalic acid in its insoluble salts.

In a similar manner the author "works through" tartaric, citric, malic, tannic, gallic, pyrogallic, formic, acetic, succinic, benzoic, stearic, palmitic, oleic, butyric, lactic, uric, and hydrocyanic acids, and lastly the humic group. In each case very full instructions are given for the recognition of such acids in the presence of other acids, organic or inorganic. It will, of course, strike the reader that many acids have been omitted, but those which have been thus thoroughly and carefully dealt with are doubtless the most important and the most generally encountered.

In the few remaining pages of this part the author enters upon an account of the characteristic behaviour of "neutral organic bodies," beginning with cellulose, starch, and cane-sugar.

Two more parts are announced. We consider that this manual, when complete, will prove of great benefit to pharmacists, public analysts, and all chemists engaged with the investigation of organic bodies.

Demonstrations in Physiological and Pathological Chemistry, with a Concise Account of the Clinical Examination of Urine. By C. H. RALFE, M.D. London: D. Bogue.

THIS work somewhat dis-commends itself to our sympathies from the fact that, like multitudes of other elementary works in all branches of science, it is avowedly examinational, and is arranged to "meet the requirements of those preparing for the examinations at the Universities of Oxford, Cambridge, and London." The idea of regulating study with reference to examinations seems to us a fundamental error. We are glad, however, to learn from the preface that a student can no longer pass in honours in physiology by dint of a good verbal memory. Says the author:—"He must prove that he has made observations for himself. He is expected to be able to prepare for microscopic examination the tissues and organs of the body, to test and separate the proximate principles and the chief products of decomposition, and to demonstrate the chemical composition and action of the secretions and the chief constituents of the tissues and nutritive fluids. In addition he is expected to make himself practically acquainted with the chief physiological instruments and the methods of employing them." This is undoubtedly no small step in the right direction.

The book contains in succession instructions for the demonstration of the saccharine and amylaceous principles, the fatty principles, the albuminous principles and their allies, the products of decomposition of the agents in and products of digestion, of the nutritive fluids, solid tissues, and the urine. Lastly, follow directions for the quantitative examination of some of the above-mentioned bodies and their constituents. A portion of the matter here given is surely needless, consisting as it does of instructions with which the student ought to be already familiar. We refer, for instance, to the figures of a chemical balance, of pipettes, burettes and their respective stands, and to the directions for weighing, &c. The characteristics of the various substances seem to us to be clearly given as far as the limited space will permit. The quantitative section is necessarily the least complete, the instructions given embracing only the determination of moisture, organic matter and salts, of uric acid in urine, of albumen in the same fluid, of lime, magnesia, potash, and soda, of free acid in urine, of urea, of alkaline and earthy phosphates, of phosphoric acid in combination with the earths, of chlorine, sulphuric acid, sugar, and iron. Probably, however, the instructions thus given are all which the plan of the book requires.

Report of the Chemical Examiner to the Government of India, May 4, 1880.

THE official laboratory at Calcutta has been exceedingly active—313 toxicological cases, besides the examination of 603 alleged poisonous substances, and 116 articles supposed to be blood-stained, represent a great and exceedingly responsible body of work. It appears that the ordinary process for the detection of aconite fails in the presence of oily matters soluble in alcohol. In the toxicological cases the most frequent poison was opium, and next arsenic, followed after a wide interval by strychnia, morphia, mercury, and aconite. For the recognition of the last-mentioned poison the method of Stas is recommended. Of the supposed poisonous articles more than one-fourth contained arsenic, datura, aconite, opium, strychnine, and

nux vomica seed being also feequent. There was one case of marking nut (*Semicarpus anacardium*). The Department is engaged with the examination of the indigenous vegetable poisons, beginning with the root of *Gloriosa superba*, a climbing liliaceous plant, common in Bengal. The active principle, superbine, is a resinous body, indifferent in its behaviour with reagents and narcotic-irritant in its action. The seeds of *Abrus præcatorius* and the bark of *Wrightea anti-dysenterica* are also under examination.

Inorganic Chemistry: adapted for Students in the Elementary Classes of the Science and Art Department. By Dr. W. B. Kemshead, F.R.A.S., F.G.S. London and Glasgow: W. Collins, Sons, and Co., Limited.

This little work is not without its suggestions. We learn from the title-page that the copy before us is one of the "twentieth thousand." If we remember what a multitude of elementary treatises on chemistry have made their appearance within the last dozen years, some of which enjoy large circulations, we cannot fail to conclude that a wonderful number of persons in these realms are studying chemistry to some extent and from some point of view. A further reflection is then near at hand: What is the result of all this study and of this preparing for examinations, elementary or advanced? Does our national share of original research increase in any ratio corresponding to the number of students? And if not, why not? Does the cause lie in some natural incapacity on our part, or in social arrangements which drive intellect away from the service of science to other fields of exertion?

Dr. Kemshead informs us that his book being specially written "for the use of pupils preparing for the first stage or elementary examination of the Science and Art Department, South Kensington, it necessarily confines itself to the subject prescribed in the syllabus of that examination. Seven only of the non-metallic elements are here dealt with—hydrogen, chlorine, oxygen, boron, carbon, nitrogen, and sulphur. The first six chapters of the book are devoted to elementary and general considerations, a prominent place being given to atomicity and to "graphic notation." These topics are necessarily introduced from the South Kensingtonian character of the work, as well as from the author's "proclivities." As regards the subject-matter it would be singular indeed if any error had crept in. The only statement to which we can fairly take exception is doubtless a clerical or typographical error. On page 183, namely, we read—"On this production of soda depend the two manufactures of *soda* and glass." We presume the author meant to say "of *soap* and of glass." In view of recent investigations it may perhaps be questioned whether boron is entitled to rank along with carbon, but its removal to a different situation would perhaps be a transgression against the "syllabus." The enormous sale of the book is sufficient proof of the reputation which it enjoys among teachers of chemistry.

Cassell's Cookery: Part I. London: Cassell, Petter, and Galpin.

Cookery is undoubtedly one of the chemical arts, and when practised rightly is based upon chemical principles, whether the operator acts in consciousness of this circumstance or is guided merely by a happy tact. The treatise before us opens wells by laying down some of these chemical principles, of which the English "plain" cook is serenely ignorant, or at least regardless. Some statements meet our eye, however, which to the man of science seem objectionable, however they may be regarded by the practical cook. Thus we find the remark anent frying-pans that "new tin is sometimes poisonous." So, alas, is old tin when it is largely alloyed with lead! We find a receipt for an abomination entitled "alum whey," into which a "teaspoonful of powdered alum, or more if preferred" is to be introduced! Alum is certainly not an article which ought ever to be taken internally, since, to say the least, it renders the phosphates which may be present in food insoluble, and causes them to be expelled from the system as waste. A receipt for "acorn coffee" might also have been judiciously omitted. We were not aware that any human being, except in the extremities of famine, would eat the berries of the mountain-ash, which are, if possible, even harsher than the cranberry. Yet it is here recommended as the material for a jelly! Black-puddings occupy a column without the needful caution as to their exceedingly unwholesome nature. Modern science pronounces that the blood of slaughtered animals finds its legitimate application, not in the kitchen, but in the manufactures of albumen for the calico-printer and of chemical manures. Even as a food for swine it ought to be interdicted.

A few verbal peculiarities may also be noted. "Vanille" is a French word for the English "vanilla." "Saleratus" is an Americanism for bicarbonate of soda—a substance which we venture to say should not be introduced into the system except under medical advice.

Regarded as a whole, we consider that this work will be useful, but we think that nothing condemned by modern chemical and physiological science should have been introduced.

Cassell's Popular Educator: Part I. London, Paris, and New York: Cassell, Petter, Galpin, and Co.

We are not surprised that a new edition of this work has been called for, and we do not doubt but that it will be well appreciated by the public. The part before us contains, however, no "lessons" in chemistry, physics, or in the arts to which they serve as a foundation, and consequently does not come under our cognisance.

CORRESPONDENCE.

NOTE ON THE ANALYSIS OF SHODDY- AND WOOL-WASTE.

To the Editor of the Chemical News.

Sir,—The remark of Mr. Hughes in the Chemical News, vol. xlii., p 325, assailing shoddy manufacturers as a body, I cannot refrain from replying to, as it would hardly be fair to leave buyers under the impression that they cannot buy this commodity on satisfactory terms, the sellers being, according to the focus of Mr. Hughes's ideas, more or less *black sheep*.

I think most of the buyers will recognise that Mr. Hughes's statements are very much overdrawn, the sampling, for instance, being now almost invariably done by the buyers themselves on receipt of the goods, and they will of course in their own interests see that samples are fairly taken. *If* chemists do not know their own work, they must surely feel obliged to Mr. Hughes for pointing out to them the loss of moisture during the operation of preparing for analysis. To me it seems that Mr. Hughes proposes to analyse a *partially* dried sample. Would it not be more reasonable to dry the sample altogether and reduce the percentage of nitrogen according to the moisture present?

The *average* of *good* shoddy according to our experience should at all events be not less than 10 per cent, as our A 1 shoddy contains about 14 per cent ammonia; and while wet shoddies, adding both in carriage and working up to the cost per unit, should be as much as possible excluded, still they may according to their composition contain the percentage of ammonia Mr. Hughes denies to them.

In conclusion the fairest way to sample is as we practise it, *i.e.* taking a handful or so promiscuously from *each*

bag, and submit the mixed sample to the chemists.—I am, &c.,

Edwd. Massey.

The West Riding Shoddy Manure Co.,
Dewsbury.

BLEACHING-POWDER.

To the Editor of the Chemical News.

Sir,—Mr. Kingzett's letter in the Chemical News (vol. xliii., p. 25), evidently calls for a reply on my part, but I am unable to see of what he can complain, or how he can believe me to have forgotten his paper of May, 1875 (quoted in my "Treatise on Sulphuric Acid and Alkali," vol. iii., p. 90), because I say that most chemists assume calcium hypochlorite to exist in solutions of bleaching-powder. This opinion is not merely shared by Mr. Kingzett, but he believes he has established it with certainty by obtaining calcium hypochlorite in a crystallised state. Or should Mr. Kingzett demur to my statement that *most* chemists share his opinion on the ground that I ought to have said *all* chemists? In that case I must beg to differ from him. I, for one, although I think it very likely that $2CaOCl_2$ may at once split up in the presence of water into $Ca(OCl)_2+CaCl_2$, do not think this absolutely proven, in view of the experiments of Wolters, and at this moment a research on this subject is being pursued in my laboratory. I consider this matter all the more open to further investigation, as Mr. Kingzett in his own paper (Chemical News, vol. xxxii., p. 22) apologises for the very imperfect state of his observations; he points out that the evidence is not beyond every doubt and that his experiments should be repeated. Desirous of seeing clear in this matter, I have thrice tried preparing Mr. Kingzett's crystals, exactly as described by him from various samples of very strong bleach, but I have failed every time, and I am afraid that those crystals can only be obtained under certain conditions which are not pointed out by Mr. Kingzett; perhaps he was not aware of their importance and of their accidental presence in his case.

I also differ from Mr. Kingzett in not regarding his investigation as furnishing the strongest or any proof of the correctness of Odling's formula. The difference of that formula, Cl—Ca—OCl, from Balard's and Gay-Lussac's is precisely that the former does *not* assume $Ca(OCl)_2$ to pre-exist in dry bleaching-powder. For anyone who has read my book or even only my last paper on bleaching-powder, it is unnecessary to say I that adhere to Odling's formula, and that I do not think the fullest demonstration of the presence of $Ca(OCl)_2$ in *solutions* of bleach would disprove Odling's formula for *dry* bleach, although some chemists have actually quoted Mr. Kingzett's paper in such a sense. But how such a demonstration can be said to do the very reverse, viz., to *prove* the correctness of Olding's formula as against the older formula, which assumes $Ca(OC)_2$ to pre-exist in dry bleach, I am utterly anable to see, nor does Mr. Kingzett's paper contain any other *proof* of that correctness.—I am, &c.,

George Lunge.

The Polytechnic School, Zürich,
January 18, 1881.

BENZOL BOILING-POINTS.

To the Editor of the Chemical News.

Sir,—I have recently received a circular from a well-known manufacturer of thermometers, referring to thermometers used for this purpose, and in which the following statement occurs, viz., that "with commercial benzols, boiling or distilling at constant and uniform rates, different thermometers of admitted accuracy do not indicate the same quantity or percentage of fluid distilled. This result, which may give rise to serious inaccuracy in returning trade certificates, is due to two causes, firstly, that of inequality in the size of the bulbs of the instrument employed and quantity of contained mercury; and secondly, that of the length of the indicating column; in other words, two instruments differing by six inches in the length of the divisions marking 100° C., may occasion a variation of several per cent in the quantity of fluid distilled, although, as previously stated, passing over at a 'constant and uniform rate of speed.' A perceptible interval elapses in the time occupied by the mercury in traversing the respective distances or column, and which is sufficient to occasion the inaccuracy referred to."

Can it be true that to this circumstance is owing the very unpleasant discrepancies constantly occurring between parties engaged in the sale and purchase of commercial benzol? I should be glad to learn how far it is known to manufacturers and distillers in general, and thankful to any of my London friends willing to impart information in a question obviously of so much import.—I am, &c.,

A Country Tar Distiller.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 26, December 27, 1880.

Speed of the Propagation of Light.—A. Cornu.—A critique on the memoir of M. Gouy (*Comptes Rendus*, xci., p. 877), whose conclusions he holds to be inaccurate.

Hydrochlorates of the Metallic Chlorides, and the Reduction of Chlorides by Hydrogen.—M. Berthelot.—Combinations of the hydracids and the metallic salts derived from halogens are very general, and resemble the complex acids derived from the association of hydrocyanic acid with metallic cyanides.

An Oxygenous Base Derived from Alolol.—A. Wurtz.—Dialdane, on being heated to 100° for two days in presence of mercury, deposits a colourless resinous matter, which is represented by the formula $C_{16}H_{28}N_2O_3$. Its aqueous solution has the singular property of coagulating on ebullition, and depositing a precipitate which re-dissolves on cooling. By its composition, and by the bitterness of its solution, and of that of its hydrochlorate, it approximates to the natural oxygenous bases. Dialdane is an aldehyd, and it is not impossible that bodies of this class intervene in the natural synthesis of oxygenous bases.

A New Method of Producing Luminous Intermittent Signals.—A. Crova.—The author, in concert with Leverrier, devised, in 1870 and 1871, an apparatus for optical telegraphy, absolutely identical with that described by M. Mercadier, employing merely an oil-lamp in place of one burning petroleum.

A New Electro-dynamic Theorem.—G. Cabanellas.—If the axles of two electric machines whatsoever, theoretically free and reversible, are connected in an invariable relation of rotation, and if the one of these machines has, in a given time, conveyed in any order a definite total quantity of electricity, the other machine will have also in the same time served as the vehicle of a total quantity of electricity, likewise definite, and a function of the former.

Regulator for the Pressure of Vapours. — M. d'Arsonval.—An illustrated paper.

A New Derivative of Nitrogen Sulphide.—Eug. Demarçay.—Nitrogen sulphide exposed to the action of the yellow sulphur chloride forms various compounds, the existence of which has been pointed out by Fordos and Gélis. The author describes one of them, formed when

the sulphur chloride is in large excess. Its composition is S_4N_3Cl. The radicle S_4N_3 is capable of playing the part of a base, or an alcohol radicle, and in its constitution it approaches the sulphines of M. Cahours. The derivatives which the author has studied he names thiotrithiazyl chloride, nitrate, and bisulphate.

A Platinous Hypophosphite. — R. Engel. — The author obtains this compound by the action of hydrogen phosphide upon platinum tetrachloride.

Sodium Boro-tungstates.—D. Klein.—The author has obtained a sodium boro-duodecimo-tungstate, which he has not succeeded in purifying perfectly. Chromic and iodic acids appear to form with the molybdic and tungstic acids complex compounds, true acids, analogous to that formed by the boric and tungstic acids.

Certain Facts Relating to the Transformation of Chloral into Meta-chloral.—H. Byasson.—The author thinks the transformation is due to the action of a trace of sulphuric acid, and may be prevented or at least retarded by the action of caustic baryta.

Oxidation-Products of Cholalic Acid.—P. T. Clève. —By the action of a permanganate along with sulphuric acid there was formed not a trace of fatty acids. Oxalic acid was produced, but not acetic acid. A crystalline acid was obtained of the composition $C_{50}H_{70}O_{17}+4H_2O$. The same compound was produced by the action of chromic acid.

Distribution of Light in the Solar Spectrum: Spectrum of the Colour-Blind.—J. Macé and W. Nicati.—In three of the cases of colour-blindness examined the perception of the red is exceedingly enfeebled. In the yellow their sight is almost normal, and in the green their perception is even better than that of the normal eye. In the fourth case, on the contrary, the perception of the red is more acute than in the normal eye; the yellow is distinguished fairly, whilst the perception of the green is weakened. The blue and green are seen normally. Among the colour-blind of the same class (not perceiving the red ray) there exist decided differences in the perception of the blue and the violet. The author's experiments prove the existence of two distinct species of colour-blindness, and they overturn the theory of colours of Hering. According to this writer two photochemic substances are concerned in vision, the one in the perception of red and green, and the other in that of blue and yellow, one member of each group acting by disassimilation and the other by assimilation. The facts observed agree with the Young-Helmholtz theory of colours. We may imagine in the retina three distinct photo-chemical substances, corresponding to the three fundamental colours, red, green, and violet.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 6, 1880.

Determinations of the Vapour-Densities of the Semi-liquid Polymeres of Iso-butyl-aldehyd and some of its Products of Distillation.—F. Urech.—Not suitable for abstraction.

For Explanation.—V. Merz.—Referring to Herrn Geuther's paper (13, p. 323), the author points out that he, in conjunction with Tibriqa, made known two and a half years ago that carbonic oxide is abundantly absorbed by heated soda- and potassa-lime, with the production of formic acid (*Berichte*, x., 2117).

Syntheses by Means of Malonic Ester.—M. Conrad and C. A. Bischoff.—The authors have prepared iso-propyl-malonic ester, iso-propyl-malonic acid, iso-propyl-acetic acid, ethyl-methyl-malonic ester, ethyl-methyl-malonic acid, ethyl-methyl-acetic acid, dioctyl-malonic ester, dioctyl-malonic acid, dioctyl acetic acid, allyl-malonic ester, allyl-malonic acid, allyl-acetic acid, diallyl-malonic ester, diallyl-malonic acid, diallyl-acetic acid, benzyl-methyl-malonic ester, benzyl-methyl-malonic acid, benzyl-methyl-acetic acid, nitroso-malonic ester, nitroso-malonic acid and its potassium salt, nitroso-benzyl-malonic ester, mono-chlor-malonic ester, tartronic acid, mono-chlor-iso-butyl-malonic ester, &c.

Decomposition of Nitroso-sulph-hydantoine by Baryta, and on a New Acid, the Nitroso-thio-glycolic.—R. Maly and R. Andreasch.—This paper does not admit of useful abstraction.

Relations between Hyoscyamine and Atropine, and Conversion of the one Alkaloid into the other.—A. Ladenburg.—The author has completed the conversion of hyoscyamine into atropine, and removed every doubt as to the identity of their products of decomposition. Perhaps they are to be regarded merely as physically isomeric.

Combinations of the Benzo-trichlorides with Phenols and Tertiary Aromatic Bases.—Oscar Dœbner.—An interesting paper, which does not admit of abstraction.

Action of Phosphonium Iodide upon Carbon Disulphide.—H. Jahn.—The author had overlooked that the same subject had been previously investigated by Prof. E. Drechsel.

Hydro-camphen.—J. Kachler and F. v. Spitzer.—The authors have succeeded in obtaining hydro-camphen by treating borneol chloride dissolved in benzol, with sodium. The results are camphen and hydro-camphen. The latter compound resists even strong oxidising agents.

Benzoylised Sulpho-amido-phenol-anilides.—Jul. Post and L. Holst.—The results of these researches are expressed in tables which cannot be usefully abridged.

Inversion of the Direction of Rotation of Ordinary Malic Acid by a mere Difference in Concentration. —G. H. Schneider.—Malic acid and its salts have hitherto been regarded as lævo-rotatory. In examining the free acid, the author observed that on taking more and more concentrated solutions the specific rotation first decreased, then disappeared, when the percentage of acid had reached about 34, and in still stronger solutions passed into an increasing dextro-rotation. Hence, if only a single solution of any given body is examined, the neutral point may be accidentally chosen, and the substance may be pronounced optically inactive.

Decomposition (so-called Catalysis) of Hydrogen Peroxide in Presence of Alkalies and Alkaline Earths. —E. Schœne.—The author considers M. Berthelot's theory on the decomposition of hydrogen peroxide in presence of alkalies incomplete, as it renders no account of the simultaneous decomposition of the double oxides.

Behaviour of Hygrogen Peroxide with Potassium Iodide.—E Schœne.—The author shows that in opposition to the statement of Berthelot the result is a violent disengagement of oxygen, a yellow colouration due to liberated iodine, and an alkaline reaction of the liquid (See *Comptes Rendus*, Feb. 23, 1880).

Ethereal Oil of Onodaphne Californica.—J. M. Stillman.—The oil consists of two compounds, terpinol and umbellol, $C_8H_{12}O$, the latter not previously known.

Derivatives of the Quinon from the Hydrocarbon $C_{16}H_{12}$. Polymeres of the Quinon.—A. Breuer and T. Zincke.—The authors examine the methylamine, ethylamine, aniline, toluidine, and naphthyl derivatives. They have also examined two polymeric forms of the quinone, which they distinguish as the white and the yellow.

Behaviour of Benzoyl- and Acetyl-Carbinol on Oxidation.—A. Breuer and T. Zincke.—The products of the oxidation of benzoyl-carbinol are benzoic, amygdalic, and benzoyl-formic acids. Acetyl-carbinol yielded lactic acid, and to a slight extent pyruvic acid.

A New Kind of Ammonium Compounds.—Peter Griess.—An account of trimethyl-nitro-phenol-ammonium, trimethyl-amido-phenol-ammonium, and ortho-trimethyl-anisol-ammonium.

Pinacones and Pinacolines.—W. Thörner and T. Zincke.—A description of aceto-phenon-pinacone and aceto-pinacone.

Behaviour of the Anhydrous Alkaline Earths with Sulphurous Anhydride.—K. Birnbaum and C. Wittich.—Pure anhydrous baryta begins to absorb sulphur dioxide at 200°; at 230° complete saturation was effected in about four weeks. The product was entirely soluble in hydrochloric acid, and contained not a trace of sulphate or sulphide. Strontia absorbs sulphurous anhydride less readily than does baryta. At 290° saturation is effected in six weeks, the product being neutral strontium sulphite. Lime absorbs the gas rapidly at 400°, and in two or three days is converted into pure sulphite. Magnesia absorbs sulphurous anhydride very slowly at 326°. The weight does not become constant until after three months.

The Homologues of Phosphenyl Chloride and the Mode of Action of Aluminium Chloride.—A. Michaelis and C. Panek.—The authors have obtained tolyl-phosphor-chloride and xylyl-phosphor-chloride. Aluminium chloride acts by combining with one portion of the nascent body.

The Constitution of Selenicus Acid.—A. Michaelis and B. Landmann.—Selenious acid behaves as a true dihydroxylic acid, and quite differently from sulphurous acid.

Contributions to the Examination of Wine.—V. Wartha.

Occurrence of Vanilline in Raw Sugars.—E. O. von Lippmann.—The author demonstrates the presence of vanilline in certain crude beet-root sugars.

Diamido-triphenyl-methane.—Otto Fischer. — This base, $C_{19}H_{18}N_2$, is readily soluble in ether, alcohol, chloroform, and ligroin.

New Synthesis of Leucaniline.—Otto Fischer and P. Grieff.—Para-nitro-benzaldehyd is digested at 120° with aniline hydrochlorate and zinc chloride; the mass is dissolved at a boil in dilute sulphuric acid, filtered from the unchanged aldehyd, the filtrate mixed with strong soda lye and aniline if present; distilled off a yellow base is obtained, para-nitro-diamido-triphenyl-methan, which, if reduced with zinc powder and acetic acid, yields a leuco-base, in every respect identical with para-leucaniline, and which on oxidation passes into magenta.

A Second Triamido-triphenyl-methane (Pseudo-leucaniline).—Otto Fischer and Joseph Ziegler.—The body obtained differs from leucaniline merely by the position of one of the three amido groups.

Amido-triphenyl-methane.—Otto Fischer and L. Roser. The authors prepare this base by digesting benzhydrol and aniline hydrochlorate for fifteen to twenty hours with zinc chloride at about 150°. The product is treated with water in order to remove zinc chloride, mixed with dilute sulphuric acid, and the solid residue is freed from excess of benzhydrol and from by-products by means of ether.

A New Method of Preparing Meta-toluidine.—Oskar Widman.—The author adds in small portions five parts meta-nitro-benzaldehyd to nine parts of phosphorus penta-chloride, avoiding a great rise of temperature. When the reaction is over, the whole is poured into excess of cold water, quickly washed a few times with cold water, and dissolved in alcohol. After the first crystallisation the compound melts at 65°, and is perfectly pure.

Synthesis of Naphthyl-diphenyl-methane.—V. Hemilian.—The author has anticipated A. Lehne in the synthesis of this compound.

Ortho-hydrazin-benzoic Acid.—E. Fischer.—An account of the preparation and properties of this acid and its anhydride.

The Constitution of the Sulphur-ethanes. — C. Liebermann.—Not suitable for abstraction.

A Compound of Ether with Phosphorus Perchloride.—C. Liebermann and L. Landshoff.—This compound, which is formed by mere contact, is represented by the formula $P_3Cl_{15}C_8H_{14}O_2$.

Certain Derivative of Sulphanthraquinonic Acid.—D. A. McHoul.—A description of anthraquinon-sulphon-chloride, anthraquinon-sulphamide, anthraquinon-sulph-anilide, and anthraquinon-dimethyl-aniline-sulphone.

The Empirical Formula of Catechine.—C. Liebermann and M. Tauchert.—The analyses executed by the authors support the formula $C_{21}H_{20}O_9$, which approximates to that of Schützenberger and Rack.

Action of Chloro-carbonic Ethyl-ether upon the Phenols.—G. Bender.—An account of the behaviour of this ether with hydroquinon, resorcine, pyrocatechine, pyrogallic acid, phloro-glucine, ortho-cresol, meta-cresol, para-cresol, orcine, β-naphthol and α-naphthol.

On γ-Sulpho-iso-phthalic Acid and γ-Oxy-iso-phthalic Acid.—H. Lönnies.—A paper supplemental to that of K. Heine on the same subject.—See *Berichte*, v., 491.

Amarine and Lophine.—E. Fischer and H. Troschke.—The authors describe the transformation of amarine into lophine, the oxidation of lophine, disulpho-lophic acid, the action of bromine upon lophine, and the vapour-density of lophine.

The Fourth Mono-nitro-phenol.—F. Fittica.—This body is distinguished from ortho-nitro-phenol by its melting-point, and by the formation of a readily soluble sodium salt. It is decidedly more soluble in water than its isomer, and yields at 150° an amido-phenol, which melts at 150°, and dissolves readily in water, whilst ortho-amido-phenol does not melt below 170°, and dissolves in water with difficulty.

Certain Azo-Compounds (Continued from xiii., p. 43).—J. H. Stebbins.—An account of azo-benzol-oxy-carboxyl-benzol, parazo-sulphoxy-benzol-phloro-glucine, azo-benzol-diamido-toluol, diamido-azo-naphthaline, and azo-benzol-sulpho-cresol.

Lecture Experiments.—V. Merz and W. Weith.—These are the preparation of formic acid from carbonic oxide; the substitution of hydrogen for carbonic acid on the passage of the latter over soda-lime; the formation of oxalic acid from formic acid; the decomposition of the metallic iodides: the behaviour of hydrogen-sulphide with copper in presence of free oxygen as an instance of supplemental affinities, and the distinctions between spots of phosphorus and those of arsenic and antimony.

Action of Caustic Soda upon Cast-Iron.—H. Brunck and C. Graebe.—The compound produced is a ferric hydroxide, with a small percentage of manganese.

Action of Organic Acids upon Minerals.—An important paper, which will be introduced at length, if space permits.

Mucobromic Acid.—H. B. Hill.—The author studies the behaviour of muco-bromic acid with dry bromine.

The Oxidation-Products of Dimethyl-uric Acid.—C. F. Mabery and H. B. Hill.—The chief products are methyl-alloxan and methyl-urea, and methyl-paraban if the reaction is prolonged.

On α-tolyl-amide.—C. L. Reimer.—This compound, which is obtained as a by-product in the preparation of benzyl-cyanide, is represented by the formula C_8H_9NO.

Action of Bromine at High Temperatures upon Benzyl-cyanide and Phenyl-acetic Acid. — C. L. Reimer.—Among the products obtained and studied are dicyan-stilben, diphenyl-fumaric anhydride, and the corresponding ethyl-ether; diphenyl-fumarimide and benzoic acid produced from dicyan-stilben.

Constitution of Lactones.—Not suitable for useful abridgment.

Gum Lac from Arizona and California.—J. M. Stillman.—The Arizona lac appears to agree in composition with that from India.

Crystalline Quinoidine Borate.—J. Jobst.—The author disproves the existence of this alleged compound.

Methylen-caffeeic Acid, Methylen-homo-caffeeic Acid, and their Derived Acids.—C. Lorenz.—Not susceptible of useful abstraction.

Action of Organo-Zinc Compounds upon Quinones. Constitution of Phenanthren-quinone.—F. R. Japp.—This paper appears in full in the *Transactions of the Chemical Society*.

MISCELLANEOUS.

City and Guilds of London Institute for the Advancement of Technical Education.—Technological Examinations, May, 1881.—The City and Guilds of London Institute for the Advancement of Technical Education will afford facilities for carrying out an examination in any of the subjects enumerated in the Lists given below, wherever a class for instruction is formed, or a sufficient number of candidates present themselves, provided a Local Committee undertakes to carry out the examination according to the rules laid down in the programme. The Committee of any Art or Science School under the Science and Art Department, or any School Board, or any "Local Examination Board" connected with the Society of Arts, will be accepted as a suitable Committee for superintending the Institute's examinations. In special cases, also, the Institute may entertain propositions for the establishment of Special Local Committees for the Technological Examinations.

Subjects of Examination.

A.	B.
1. Alkali Manufacture.	2. Brewing.
3. Cotton Manufacture.	4. Calico Bleaching, Dyeing, and Printing.
5. Electro-Metallurgy.	6. Carriage Building.
7. Flax.	8. Cloth Manufacture.
9. Fuel.	10. Gas Manufacture.
11. Glass Manufacture.	12. Silversmiths' Work.
13. Mechanical Engineering.	14. Lace Manufacture.
15. Mine Surveying.	16. Iron and Steel Manufacture.
17. Oils, Colours, and Varnishes, Manufacture of.	18. Oils (Illuminating and Lubricating).
19. Paper Manufacture.	20. Ores, Mechanical Preparation of.
21. Plumbers' Work, Zinc, and Tin-Plate Work.	22. Photography.
23. Silk Manufacture.	24. Pottery and Porcelain.
25. Sugar Manufacture.	26. Printing.
27. Telegraphy.	28. Silk Dyeing.
29. Watch and Clock Making.	30. Tanning Leather.
31. Wool Dyeing.	32. Tools.

Candidates may be examined in any one subject out of list A, as well as in any one subject out of list B. The examinations will be in three grades:—I. Elementary; II. Advanced; III. Honours. Certificates (First and Second Class) will be awarded in each grade. The following Prizes will be offered in each subject:—Honours—1st Prize, £5 and a Silver Medal; 2nd Prize, £5 and a Bronze Medal. Advanced—1st Prize, £3 and a Silver Medal; 2nd Prize, £3 and a Bronze Medal. Elementary—1st Prize, £2 and a Silver Medal; 2nd Prize, £2 and a Bronze Medal. The examinations for the year 1881 will be held on the evenings of May 25 and May 26, the examinations in the subjects of list A on May 26, and in those of list B on May 25. There is no limit of age. Any persons desiring to be examined should apply not later than April 21, to the Central Office in London. Copies of the Programme, containing full particulars of the Examinations, a Syllabus of each subject, and the Examination Papers of 1880, can be obtained from the Central Office of the City and Guilds of London Institute, Gresham College, London, E.C.

MEETINGS FOR THE WEEK.

MONDAY, 31st.—London Institution, 5.
— Medical, 8.30.
— Royal Geographical, 8.30.
TUESDAY, 1st Feb.—Civil Engineers, 8.
— Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
WEDNESDAY, 2nd.—Society of Arts, 8.
— Pharmaceutical, 8.
— Geological, 8.
THURSDAY, 3rd.—London Institution, 7.
— Royal, 4.30.
— Geologists' Association, 8.
— Royal Institution, 3. "The Troubadours," Mr. F. Hueffer.
— Chemical, 8. "On the Estimation of Organic Carbon in Air," Drs. Dupré and Hake. "On the Action of the Copper Zinc Couple upon Nitrates," Mr. W. Williams.
FRIDAY, 4th.—Royal Institution, 8. "Colonial Organisms," Dr. A. Wilson, 9.
SATURDAY, 5th.—Royal Institution, 3. "The Amazons," Prof. S. Colvin.

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HENRY H. TOWNSEND, Secretary.

Gas Offices, Canons' Marsh, Bristol,
8th January, 1881.

BOROUGH OF SALFORD.—TO TAR DISTILLERS, &c.—The Corporation of Salford invite TENDERS for the TAR and AMMONIACAL LIQUOR which may be made at their Gasworks for a period of three years from the 13th of July next. Security will be required for the due fulfilment of the contracts. Printed particulars of quantity and conditions of contract and forms of tender may be obtained on application to the Engineer, Mr. Samuel Hunter, Gas Offices, Bloom Street, Salford. Tenders, sealed and endorsed "Tender for Tar or Ammoniacal Liquor," as the case may be, must be delivered to me on or before the 15th day of February next. The Corporation do not bind themselves to accept the highest or any tender.—By order.

CHRIS. MOORHOUSE, Town Clerk.

Town Hall, Salford, 21st January, 1881.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the 'Journal of the Chemical Society"; also Vol. 3 of the 'Proceedings of the Royal Society."—Address, K. P. G., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1105

CONTRIBUTIONS TO THE EXAMINATION OF WINE.

By V. WARTHA.

1. *Detection of Magenta in Red Wines.*

In all judicial cases the following should be applied in succession :—

a. The Magnesia Test.—20 c.c. of the wine are mixed in a large test-tube with excess of calcined magnesia. After well shaking there is added 1 c.c. of a mixture of equal parts colourless amylic alcohol and ether; the whole is well shaken and allowed to stand for some time. 1 m.grm. magenta in 1 litre wine may be detected by a rose colouration of the supernatant stratum. In strongly coloured southern wines faint reactions are often masked by a yellowish or light brownish colouring-matter.

b. The Sugar of Lead Test.—20 c.c. of wine are mixed with 10 c.c. sub-acetate of lead of officinal strength, and the mixture after being well shaken is filtered into a perfectly dry test-tube. If moderately large quantities of magenta are present they will be detected by the paler or deeper rose colour of the filtrate. But even if it appears perfectly colourless or yellowish, small quantities of magenta or aniline-violet may be present. 1 c.c. of the above-mentioned mixture of amylic alcohol and ether is therefore added; the tube shaken up, and then allowed to stand for some time. If held against a white background very small quantities of magenta may be recognised in the upper stratum.

c. The Ether Test.—If the sample has given strong reactions with *a* and *b*, concentration is not necessary. If the reactions were slight, from 150 to 200 c.c. of the wine are evaporated down to one-third to one-fifth of its original volume in a silver capsule, which should have been slightly ignited previously. The concentration is effected over an open flame as rapidly as possible, and the residue while still warm is poured into a stoppered glass cylinder, which should previously be washed with concentrated nitric acid and rinsed with pure water. The wine is mixed with an excess of pure ammonia, 30 to 40 c.c. pure ether are added, the cylinder is stoppered, and shaken carefully to prevent the formation of an emulsion. The clear ethereal stratum is then filtered through a clean dry filter into a perfectly clean porcelain capsule having glazed edges. One or two threads of clean knitting-wool, 3 to 4 c.m. long, which should have been previously washed and dried, are laid in the colourless ether, which is allowed to evaporate in a warm place. The wool takes a colour which may vary, according to the proportion of the magenta, from a faint rose to a red. One of the threads is then reserved in a tube, whilst the other is cut in two, the one half moistened with hydrochloric acid, and the other with ammonia. In both these the red colour should change to a yellowish. If aniline-violet was present the threads will turn to a green. If the wine was pure, however deep in colour, the wool remains white. Particular care must be taken that the ammonia employed contains no traces of organic colouring-matters.

2. *Detection of Sulphurous Acid in Wines.*

About 50 c.c. of the sample are placed in a small distilling flask, the lateral exit-tube of which projects into a test-tube cooled with moistened filter-paper. The wine is kept at a gentle boil till 2 c.c. have distilled over. The test-tube is taken off and a few drops of a neutral solution of silver nitrate are added. If even traces of sulphurous acid were present the liquid becomes opalescent or a white curdy precipitate of silver sulphite is formed, which is distinguished from silver chloride by its solubility in nitric acid. The distillate also reduces mercurous nitrate and decolourises starch iodide and weak solution of potassium permanganate.—*Berichte der Deut. Chem. Gesellschaft zu Berlin*, No. 6, 1880.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, from December 20th, 1880, to January 19th, 1881

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

January 21, 1881.

Sir,—We desire to lay before you the results of our examinations and analyses of daily samples of the water delivered in London by the seven Companies deriving their supply from the Rivers Thames and Lea, for the month ending Jan. 19th. The samples are collected by a man entirely under our own control, at places and at times appointed by us, and unknown to the officers of the several Companies.

As yet no daily analyses of the London waters have been recorded. All the reports hitherto published relate to a single sample of each Company's water taken on one day only in the course of a month. It is manifestly impossible to judge the character of a whole month's supply by a single sample. This may prove to be very good, whilst the water supplied during the rest of the month may be very bad or *vice versâ*.

In Table I. we have recorded the analyses in detail of a daily sample (excluding Sundays and Christmas Day) between Dec. 20th, 1880, and Jan. 19th, 1881.* The purity of the water in respect of organic matter, has been determined by the oxygen and the combustion processes, the results of our analyses by these methods being stated in columns XIV. to XVIII.

In Table II. is recorded the colour, together with the clearness or turbidity of each sample. Of the 169 samples collected by us between Dec. 20th, 1880, and Jan. 20th, 1881, 139 were found "*clear*," 21 were noted as "*very slightly turbid*," 8 as "*slightly turbid*," and 1 as "*turbid*."

The samples supplied by the New River Company were, without exception, clear, bright, and efficiently filtered.

Of the 24 samples from the mains of the East London Company, 2 were noted as "very slightly turbid." The remainder were, bright, clear, and well filtered.

Of the 24 samples from the mains of the Chelsea Water Company, 2 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 25 samples from the mains of the West Middlesex Company, 1 was noted as "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Lambeth Water Company, 3 were noted as "very slightly turbid," and 4 as "slightly turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Grand Junction Company, 6 were noted as "very slightly turbid," 4 as "slightly turbid," and 1 as "turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Southwark

* The severe weather interfered with the collection of samples on the 18th and 19th of January.

{ Chemical News Feb. 4, 1881.

TABLE I.

RESULTS OF THE ANALYSIS OF DAILY SAMPLES OF THE WATER AS SUPPLIED TO THE METROPOLIS, FOR THE MONTH ENDING JANUARY 19TH, 1881.

The Results are stated in Grains per Imperial Gallon of 70,000 Grains, except the Organic Carbon and Nitrogen, which are expressed both in Grains per Gallon and in Parts per 100,000.

I.	II	III.	IV.	V	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
No.	Date of Collection.	Time of Collection.	Company from the Mains of which the Sample was drawn.	Place where the sample was drawn.	Appearance in 2-ft. tube. *	Matters in Suspension.	Ammonia.	Chlorine = Common Salt (NaCl).		Nitrogen = Nitric Acid (HNO_3).		Initial Hardness.	Oxygen required to Oxidise the Organic Matter. †	Organic Carbon.	Organic Nitrogen.	Organic Carbon.	Organic Nitrogen.
						Grains.	Grains.	Grains = Grains.		Grains = Grains.		Degrees.	Grains.	Prts. per 100,000.		Grs. per Gln.	
	1880-81.	p.m.															
1	Dec. 20	6. 0	New River	Islington Green	C.	None.	0·000	1·152 = 1·888		0·219 = 0·985		15·4	0·020	0·108	0·014	0·075	0·009
8	,, 29	5.30	New River	Islington Green	C.	None.	0·000	1·008 = 1·652		0·229 = 1·030		15·4	0·060	0·152	0·030	0·106	0·021
15	Jan. 6	6.25	New River	Islington Green	C.	None.	0·000	1·008 = 1·652		0·240 = 1·080		15·4	0·039	0·108	0·012	0·076	0·008
22	,, 14	3.15	New River	Islington Green	C.	None.	0·000	1·008 = 1·652		0·250 = 1·125		16·5	0·040	0·122	0·026	0·085	0·016
2	Dec. 21	4. 0	East London	London Hospital College	V. S. T.	? ‡	0·000	1·080 = 1·770		0·208 = 0·936		15·9	0·054	0·172	0·023	0·120	0·016
9	,, 30	2.10	East London	London Hospital College	C.	None.	0·000	1·008 = 1·652		0·208 = 0·936		15·9	0·060	0·146	0·028	0·102	0·019
16	Jan. 7	4.50	East London	London Hospital College	C.	None.	0·000	1·152 = 1·888		0·188 = 0·846		15·4	0·056	0·151	0·028	0·105	0·019
23	,, 15	5. 0	East London	London Hospital College	C.	None.	0·000	1·008 = 1·652		0·240 = 1·080		16·5	0·048	0·116	0·020	0·081	0·014
3	Dec. 22	8. 0	Chelsea	Horse Guards	V. S. T.	? ‡	0·000	1·080 = 1·770		0·208 = 0·936		16·5	0·031	0·100	0·016	0·070	0·011
10	,, 31	7.45	Chelsea	Horse Guards	C.	None.	0·000	1·008 = 1·652		0·198 = 0·891		14·8	0·068	0·214	0·032	0·149	0·022
17	Jan. 8	8. 0	Chelsea	Horse Guards	C.	None.	0·000	1·008 = 1·652		0·167 = 0·752		15·4	0·061	0·182	0·030	0·127	0·021
24	,, 16	3. 0	Chelsea	Horse Guards	C.	None.	0·000	1·008 = 1·652		0·198 = 0·891		15·9	0·048	0·131	0·022	0·091	0·015
4	Dec. 23	7.30	West Middlesex	Portland Road	C.	None.	0·000	1·008 = 1·652		0·203 = 0·913		15·9	0·017	0·110	0·020	0·077	0·014
11	Jan. 1	6.15	West Middlesex	Portland Road	C.	None.	0·000	1·008 = 1·652		0·188 = 0·846		15·4	0·086	0·226	0·032	0·158	0·022
18	,, 10	6.20	West Middlesex	Portland Road	C.	None.	0·000	1·008 = 1·652		0·198 = 0·891		15·9	0·068	0·227	0·031	0·158	0·021
25	,, 19		West Middlesex	Portland Road	C.	None.	0·000	1·080 = 1·770		0·198 = 0·891		16·5	0·056	0·162	0·022	0·113	0·015
5	Dec. 24	7. 0	Lambeth	Westminster Bridge Road	C.	None.	0·000	1·080 = 1·770		0·198 = 0·891		15·9	0·066	0·145	0·034	0·108	0·023
12	Jan. 3	7.45	Lambeth	Westminster Bridge Road	S. T.	? ‡	0·001	1·080 = 1·770		0·198 = 0·891		15·4	0·090	0·274	0·042	0·191	0·029
19	,, 11	7.55	Lambeth	Westminster Bridge Road	C.	None.	0·000	1·008 = 1·652		0·198 = 0·891		16·5	0·040	0·123	0·022	0·086	0·015
6	Dec. 27	2.20	Grand Junction	Lancaster Gate	C.	None.	0·000	1·080 = 1·770		0·198 = 0·891		16·5	0·088	0·248	0·042	0·173	0·029
13	Jan. 4	6.50	Grand Junction	Lancaster Gate	S. T.	? ‡	0·001	1·008 = 1·652		0·188 = 0·846		15·0	0·096	0·273	0·040	0·191	0·028
20	,, 12	6.45	Grand Junction	Lancaster Gate	C.	None.	0·001			0·240 = 1·080		15·9	0·048	0·174	0·032	0·121	0·022
7	Dec. 28	8.25	Southwark and Vauxhall	St. George's Church, Boro'	C.	None.	0·001	1·152 = 1·888		0·198 = 0·891		14·3	0·106	0·314	0·044	0·219	0·030
14	Jan. 5	8.20	Southwark and Vauxhall	St. George's Church, Boro'	C.	None.	0·001	1·008 = 1·652		0·188 = 0·846		14·8	0·086	0·254	0·038	0·177	0·026
21	,, 13	9.35	Southwark and Vauxhall	St. George's Church, Boro'	V. S. T.	? ‡	0·000	1·008 = 1·652		0·229 = 1·030		16·0	0·048	0·150	0·036	0·105	0·025

* See Table II. † The amount of oxygen is determined by a standard solution of Potassic Permanganate in the cold acting for three hours. ‡ Incapable of estimation.

TABLE II.

Showing the Appearance in a Two-foot Tube, and Condition, as Regards Turbidity, of the Waters Daily Supplied to the Metropolis by the London Companies, for the Month ending, January 19th, 1881.

No.	Date of Collection.	New River Company.	East London Company.	Chelsea Company.	West Middlesex Company.	Lambeth Company.	Grand Junction Company.	Southwark and Vauxhall Compy.
	1880.							
1	Dec. 20	C. G. 0	C. G. 0	V. S. T. G. 1	C. G. 0	C. Y. G. 1	C. G. 2	V.S.T. G. 2
2	,, 21	C. G. 0	V. S. T. G. 1	C. G. 1	C. G. 0	C. Y. G. 1	C. G. 2	V.S.T. Y. G. 2
3	,, 22	C. G. 0	C. G. 1	V. S. T. G. 1	V.S.T. G. 1	C. Y. G. 1	T. Y. G. 2	V.S.T. Y. G. 2
4	,, 23	C. G. 0	C. G. 1	C. G. 1	C. G. 2	C. Y. G. 1	V. S. T. Y. G. 2	C. Y. G. 2
5	,, 24	C. G. 1	C. G. 1	C. G. 1	C. Y. G. 1	C. Y. O. 1	S. T. Y. G. 2	C. Y. G. 2
6	,, 27	C. G. 1	C. G. 2	C. G. 2	C. Y. G. 1	C. Y. G. 2	C. Y. G. 2	C. Y. G. 2
7	,, 28	C. G. 1	C. G. 1	C. G. 2	C. Y. G. 1	S. T. Y. G. 2	V. S. T. Y. G. 2	C. Y. G. 2
8	,, 29	C. G. 0	C. G. 0	C. G. 2	C. Y. G. 1	C. Y. G. 2	V. S. T. Y. G. 2	C. Y. G. 2
9	,, 30	C. G. 1	C. G. 1	C. G. 2	C. Y. G. 2	C. Y. G. 2	C. Y. G. 2	C. Y. G. 2
10	,, 31	C. G. 0	C. G. 1	C. G. 1	C. Y. G. 2	S. T. Y. G. 2	C. Y. 2	C. Y. 2
	1881.							
11	Jan. 1	C. G. 1	C. G. 1	C. G. 2	C. Y. G. 2	S. T. Y. G. 2	S. T. Y. 2	C. Y. G. 2
12	,, 3	C. G. 0	C. G. 1	C. G. 2	C. Y. G. 2	S. T. Y. G. 2	S. T. Y. O. 2	C. Y. 2
13	,, 4	C. G. 1	C. G. 1	C. G. 1	C. Y. G. 1	V. S. T. Y. 2	S. T. Y. G. 2	V. S. T. Y. 2
14	,, 5	C. G. 0	C. G. 1	C. Y. G. 1	C. G. 1	C. G. 2	C. Y. G. 2	C. Y. G. 1
15	,, 6	C. G. 1	V. S. T. O. 2	C. O. 1	C. G. 1	V. S. T. Y. G. 1	V. S. T. Y. G. 1	C. Y. G. 1
16	,, 7	C. G. 1	C. G. 1	C. G. 1	C. G. 1	C. Y. G. 1	V. S. T. Y. G. 1	C. Y. G. 1
17	,, 8	C. G. 1	C. O. 1	C. G. 1	C. G. 1	C. O. 1	V. S. T. Y. G. 1	C. Y. G. 1
18	,, 10	C. G. 1	C. G. 1	C. G. 1	C. Y. G. 1	C. G. 1	C. Y. G. 1	C. Y. G. 1
19	,, 11	C. G. 0	C. G. 1	C. Y. O. 1	C. Y. G. 1	C. G. 1	C. G. 1	C. Y. G. 1
20	,, 12	C. G. 0	C. G. 1	C. O. 1	C. G. 1	V. S. T. Y. G. 1	C. Y. G. 1	C. Y. G. 1
21	,, 13	C. G. 1	C. G. 1	C. G. 1	C. G. 1	C. O. 1	C. G. 1	V. S. T. G. 1
22	,, 14	C. G. 0	C. O. 1	C. G. 2	C. G. 2	C. G. 2	C. G. 1	V. S. T; G. 2
23	,, 15	C. O. 1	C. G. 1	C. G. 2	C. G. 2	C. G. 1	C. G. 1	C. Y. G. 1
24	,, 17	C. G. 1	C. G. 2	C. O. 2	C. G. 1	C. G. 1	C. G. 1	V.S.T. Y. G. 1
26	,, 19	—	—	—	C. G. 2	—	—	—

Degrees of Turbidity.

Note :— C. = Clear.
V. S. T. = Very slightly turbid.
S. T. = Slightly turbid.
T. = Turbid.

Degrees of Tint Depth.

Note :— B. = Blue.
O. O = Green.
G. 1 = Green 1.
G. 2 = Green 2.
Y. G. O = Yellowish green.
Y. G. 1 = Yellowish green 1.
Y. G. 2 = Yellowish green 2.
Y. O = Yellowish.
Y. 1 = Yellowish 1.
Y. 2 = Yellowish 2.

TABLE III.

Showing the Quantity of Free Oxygen in Daily Samples of the Water supplied to the Metropolis, for the Month ending January 19, 1881.

The Results are stated in Cubic Inches per Imperial Gallon.

No.	Date of Collection.	New River Company.	East London Company.	Chelsea Company.	West Middlesex Company.	Lambeth Company.	Grand Junction Company.	Southwark and Vauxhall Company.
	1880.							
1	Dec. 20	1·76	1·85	1·68	1·85	1·85	1·85	1·76
2	,, 21	2·24	1·76	1·85	2·13	1·68	2·13	1·68
3	,, 22	1·96	1·85	1·79	1·85	1·79	2·04	1·57
4	,, 23	1·85	1·76	1·79	1·76	1·73	2·13	1·93
5	,, 24	1·68	1·57	1·69	1·57	1·71	1·68	1·93
6	,, 27	1·76	1·93	1·57	1·76	1·62	1·68	1·51
7	,, 28	1·58	1·59	1·59	1·68	1·48	1·68	1·59
8	,, 29	1·51	1·57	1·60	1·43	1·57	1·43	1·59
9	,, 30	1·51	1·48	1·59	1·57	1·82	1·59	1·59
10	,, 31	1·62	1·83	2·43	1·43	2·32	1·59	2·43
	1881.							
11	Jan. 1	2·04	2·01	2·46	2·05	2·30	1·73	2·27
12	,, 3	2·43	2·04	2·10	2·30	2·00	1·98	1·98
13	,, 4	2·35	2·04	1·90	2·18	2·07	2·15	1·98
14	,, 5	2·07	2·13	2·30	1·98	1·98	2·01	2·28
15	,, 6	2·10	1·79	2·21	2·24	2·24	2·46	2·24
16	,, 7	2·21	1·69	2·01	2·32	1·62	2·21	1·96
17	,, 8	1·90	1·71	2·10	2·07	1·62	1·85	2·10
18	,, 10	1·88	1·71	2·60	2·10	2·68	2·18	2·68
19	,, 11	2·68	2·68	2·27	2·66	2·21	2·57	2·66
20	,, 12	2·28	2·21	2·15	2·49	2·32	2·43	2·50
21	,, 13	2·57	2·18	2·38	2·50	2·32	2·38	2·46
22	,, 14	2·43	2·46	2·41	2·66	2·38	2·55	2·60
23	,, 15	2·50	2·18		1·99		2·38	
24	,, 17							
25	,, 18							
26	,, 19							

and Vauxhall Company, 7 were noted as "very slightly turbid." The remainder were clear, bright, and efficiently filtered.

If a trace of suspended matter be noted, we record the water as "turbid." If on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid." A water is recorded as "slightly turbid" when we consider it would come between those two extremes.

In Table III. we have recorded the quantity of free oxygen in the 158 samples.

We desire to add, that from these analyses we are of opinion that considered both chemically and physiologically, the water delivered by the Companies during the month over which these examinations extended was of excellent quality, wholesome, and in every respect well fitted for the supply of the Metropolis.—We remain, Sir, your faithful servants,

William Crookes,
William Odling,
C. Meymott Tidy.

REMARKS ON "SOME EXPERIMENTS WITH MALTOSE."

By J. STEINER, F.C.S.

The paper published by Mr. Yoshida in the Chemical News, vol. xliii., p. 29, though interesting, seems to me to require correcting in some points.

1. The specific rotatory power of maltose, if calculated from the appended analytical data, is not $(\alpha)j = 150{\cdot}25$, but less. Mr. Yoshida used Soleil-Ventzke's saccharimeter for examining the optical properties of his crystallised sugar. Now the number of angular degrees corresponding to 100 divisions on the scale of this instrument, is not 39·61, as introduced in his calculations, but less. 26·048 grms. of pure cane-sugar dissolved to 100 c.c., causes in a layer of 200 m.m., a rotation which is marked on the scale of this apparatus as 100. From experiments concerning the rotatory power of cane-sugar, as carried out by Tollens and also by Schmidt, it follows that this concentration in the given length produces a deviation of the sodium ray which equals 34·6 angular degrees. Further, it is an established fact that quartz disperses the single rays of the white light in exactly the same manner as is done by cane-sugar in aqueous solutions. Broch, who examined very carefully the optical activity of quartz, noticed for a plate of 1 m.m. in thickness a deviation of 21·67 angular degrees for the sodium light and 24·5 for the white lamp light. These data may be arranged in the following proportion, $21{\cdot}67 : 24{\cdot}5 = 34{\cdot}6 : (x = 39{\cdot}1)$, which shows that for 100 divisions of Soleil-Ventzke's scale 39·1 angular degrees have to be taken into account, when the specific rotatory power for the transition tint $(\alpha)j$ is to be calculated for. On using the factors 34·6 and 39·1 in conjunction with Mr. Yoshida's analytical data the values $(\alpha)_D = 131{\cdot}3$ and $(\alpha)j = 148{\cdot}3$ are obtained, and they are remarkable for being very low.

Mr. Yoshida does not mention anything about the water of hydration of maltose crystals, and yet it is well known that maltose crystallises with one molecule of water, which corresponds to an increase in weight of 5 per cent. Suppose Mr. Yoshida used crystals for his experiments, then the numbers for the specific rotation would have to be increased in the proportion of 95 : 100, and the results would be $(\alpha)_D = 138{\cdot}2$ and $(\alpha)j = 156{\cdot}1$ for anhydrous maltose.

A few months ago, Prof. Soxhlet, in Munich, kindly gave to me a sample of his specially purified and distinctly crystalline maltose. A solutions of it, containing 11 per cent of perfectly air dry crystals, and being quite colourless and bright, was examined in a Ventzke-Scheibler polarimeter, with the result of $(\alpha)_D = 138{\cdot}9$ for anhydrous maltose. Dr. Meissl in Vienna, who examined solutions containing about 20 per cent of dry maltose, obtained the value $(\alpha)_D = 139{\cdot}3$. Mr. Yoshida used solutions with 6·4 and 10 grms. per 100 c.c., and it seems most probable that the numbers given by him are merely the values for crystallised maltose.

There is another point concerning the rotation of maltose which requires mentioning, and it is this: Soxhlet noticed that maltose solutions possess the peculiar property of what is called by-rotation, similarly as is the case with dextrose. But while the optical activity of dextrose decreases considerably after 24 hours standing, or half an hour's boiling, the deviation caused by maltose becomes somewhat greater in a few hours from the time when it was dissolved. The sample of maltose which was examined by myself showed a distinct by-rotation. Mr. Yoshida does not mention anything on this point, and it is likely that he did not take it into consideration.

2. In regard to the determination of the CuO reducing power of maltose, there is this to be said: Soxhlet found out by experiments that the concentration of the copper and sugar solution influences the reducing power of different sugars. Concerning maltose it has been established that the reducing action increases with the dilution of the test liquor. If, however, Fehling's solution is applied without diluting it, the action of maltose, in a solution containing no more than about 1 per cent of this sugar, is independent of the excess of test liquor, and in this case 100 maltose are equivalent to 113 copper or 141·5 CuO. Now Mr. Yoshida diluted his copper solution five times, and yet he obtained only 460·31 CuO for one equivalent (342) of maltose, *i.e.*, 134·62 CuO for 100 maltose. This result also seems to me to prove that the CuO reducing power calculated by him as 61, is that of the crystals, while the proportion, $95 : 100 = 61 : (x = 64{\cdot}2)$, shows that for anhydrous maltose K = 64·2. Mr. Yoshida operated under circumstances which are similar to those used and recommended by Mr. O'Sullivan, and naturally enough the result differs not much from the value K = 65 as given by that investigator.

3. The experiments carried out by Mr. Yoshida for the purpose of studying the reducing action of maltose on an ammoniacal copper solution are interesting, as they show the effect produced by using ammonia of different strength for this test.

The reducing power of maltose is not so easily influenced, as is the case for that of dextrose or glucose, on varying the strength and amount of ammonia of the test. A direct comparison, however, of the ammoniacal test with the ordinary copper test is not given by Mr. Yoshida. The actual influence of more or less alkali in Pavy's test liquor, has first been pointed out by Mr. Hehner, while a close comparison of the results obtained with the two tests were given by myself (Chemical News, vol. xl., p. 139) in the following manner: 20 c.c. of Fehling's solution were applied for the usual test, and then I repeated the experiment with the same amount of test liquor after the addition of 40 c.c. of strong ammonia. I then noticed that the action of maltose remained the same in both cases, while with dextrose and invert-sugar, the reduction became more energetic in presence of ammonia.

4. The result of the action of glacial acetic acid upon maltose is very satisfactory if the method described by Liebermann and Hormann is applied. Equal quantities of dry substance and acetate of soda are mixed with about 3 to 4 times of acetic anhydride and warmed in a flask. The action being very energetic, is completed in 10 to 15 minutes. After cooling the flask a solid cake is obtained, and on the addition of an excess of water, the maltose acetyl separates in flocks, which are soluble in hot alcohol. On gradually evaporating the spirit, crystals separate, which represent the highest acetyl derivate of maltose.

An elementary analysis of this substance, carried out by Herzfeld, yielded results which agree closely with the formula—

$$C_{12}H_{10}O_{11}.(C_2H_3O)_{12}.$$

It is clear that in this case a conclusion as to the nature and constitution of the maltose molecule can be drawn much easier than if merely the mono-acetyl derivate is taken into consideration.

ON THE

CHEMISTRY OF SEWAGE PRECIPITATION.*

By Dr. WILLIAM WALLACE.

The subject which I propose to bring before you is one to which, for several years, I have devoted much attention, and I have thought that it might not be uninteresting to the members of the Section to have it introduced to their notice. Although it is with precipitation of sewage that we have to do, yet I trust you will bear with me if I digress at times into collateral branches of the subject.

There are three distinct products of the animal body :—First, there is the gaseous, consisting chiefly of carbonic acid gas and watery vapour, resulting from the oxidation of the respiratory food,—fat, sugar, starch, and so on—and this may be called the gaseous refuse or sewage of the body ; second, there is the liquid excrement or urine, and this consists essentially of water holding in solution the partially-oxidised products of the waste tissues of the body ; lastly, there is the solid excrement, consisting of that portion of our food which has escaped digestion, but altered to some extent by the functions of the body. It is with the two latter alone that we are concerned. They form the most important and essential portion of sewage. But there are other sources of pollution—that is, putrescible matter—besides the animal products. These consist of such things as the water poured off from boiled vegetables and meat, the washings of dishes and kitchen utensils, the water used in washing our own bodies and in washing clothes, the surface drainage of the streets ; besides refuse matter of various kinds from workshops and factories, chemical works, breweries, distilleries, and so on. Sewage is thus a very mixed liquid, and this is one of the difficulties of disposing of it. Still, it is a thing we have to deal with, and, such being the case, the question is how to get rid of it in the most convenient, the least injurious, and the least expensive manner.

There can be little doubt as to the original method of disposing of the animal products in what may be called the normal state of existence, when every family lived apart, surrounded by plenty of ground. Yet even in ancient times it was found necessary, for the well-being of the community, as we find described in the Mosaic record, to make sanitary regulations for the proper disposal of the excreta of the camp or household. As families began to congregate into towns the difficulties increased ; and it is one of the great evils of town life that no perfect system for dealing with excreta has yet been carried out. If we examine towns where a dry system alone is in operation, as in most of the inland Continental towns, we find that there is a general unsavouriness about them, while the closets are generally odorous to a painful degree. On the other hand, the wet system has evils peculiar to itself, although, upon the whole, a water-closet town is cleaner and less offensive than the other description : yet its underground sewers generate gases, by which the soil is permeated and the houses rendered unwholesome ; and the gases escaped through imperfect traps and corroded pipes into the houses. If the sewers could all be kept on the surface of the ground, with a constant run of water in them, there would be no danger from this cause ; for sewage mixed with sufficient water to ensure it being kept in motion and freely exposed to the air, will never become dangerous to health, although it may be more or less offensive to the senses of sight and smell. Perhaps the most perfect town, sanitarily, that we could imagine would be one which had in the centre of every street a copious stream of water running in a perfectly smooth channel, and with sufficient fall to prevent any lodgment of solid matter. Into this stream the sewage of every house would pass, and it might be covered over at intervals, or even throughout its whole length, with a grating so open as to give perfect access of air to the stream below, its bed being only a few inches below the level of the street. It is when excretal matter is shut up that it becomes dangerous to health. Nature has provided for its deodorisation and oxidation by mixture with the porous soil and free exposure to the air ; and if we defy nature, as it were, by keeping it underground, shut up from the purifying influence of atmospheric oxidation, we must be content to reap the consequences in a class of diseases which appear to be peculiarly the result of the decomposition of excremental matter under these conditions.

A great deal has been said and written about the purifying action of water, but I wish to point out to you that water, *per se*, has no purifying action whatever. If we were to mix excreta with pure or boiled water it would certainly dilute it, but it would not prevent its decomposition and consequent offensiveness in the slightest degree. But water in nature is never pure—it contains in solution both mineral salts and gases, one of which is oxygen, which usually constitutes one-third of the whole. This oxygen in water undoubtedly exerts a most powerful influence on sewage, but then it requires an enormous volume to yield sufficient oxygen to render innocuous a very small quantity of excreta. A gallon of water contains, we may assume, 2¼ cubic inches of oxygen gas, but the weight of this is only 0·9 of a grain ; while, according to my calculation, a gallon of urine would require for its complete oxidation about 3000 grains of oxygen. It is only in extreme cases that we can have the opportunity of mixing animal products with 3000 times their bulk of water ; but if we could do so, and provided there was no solid matter to settle down, there would be complete oxidation and purification. In ordinary cases we have to depend more upon contact with the air for the oxidation than the mere mixture of water, which, as I have shown you, possesses but a limited power. With regard to river pollution, the influence of sewage must be considered with reference to quantity. For example, the drainage of a small village somewhere about Tintock would be completely swallowed up and rendered perfectly harmless before it reached Glasgow ; but when we throw into the Clyde the excrements of nearly three-quarters of a million of people, we tax the powers of air and water too severely, and the once noble river becomes, at the harbour, a seething puddle, a gigantic cesspool. And yet it has by no means been satisfactorily proved that the condition of the river, disgusting as it is in summer, is directly dangerous to health. The question of the conservancy of rivers is one that has for some time been engaging the attention of sanitary authorities. In the case of a number of towns, such as Bradford and Leeds, the purified sewage is incomparably purer than the grossly-polluted streams into which it flows. These and other towns are subjected to the manifest injustice of being compelled, under heavy penalties, to render their sewage clear, inodorous, and almost perfectly colourless, before discharging it into rivers or streams, which are often, as in the case of the Bradford Beck, literally common sewers of the foulest description. The inhabitants of these towns complain, and with good reason, that in the upper reaches of the rivers wholesale pollution is permitted, while they have been put to great expense in order to accomplish a purification, the effects of which are swallowed up in the filth of other towns over which they have no control. Conservancy Boards to watch over the whole drainage area of the various river basins appear to be the only effectual means of solving the important questions which are so intimately connected—the disposal of sewage and the restoration of rivers to a state of purity.

There are two ways in which excremental matter may be dealt with—the dry system, and carriage by water,

* A Paper read before the Chemical Section of the Philosophical Society of Glasgow, December 6, 1880.

The first is the most rational, as well as the most consistent with public health and with national prosperity. The weak part of this system is that, while it disposes of excreta, it leaves untouched all other kinds of sewage, which still require to be removed by means of water-carriage, and demand the same purification before passing into a river as the excreta themselves. While, therefore, upon economical and sanitary grounds, water-closets, especially in houses of the smaller sort, and in public works, jails, railway stations, &c., might, with advantage, be replaced by an efficient dry system, the adoption of this course would not greatly lessen the ammont of sewage to be dealt with, or render its purification less imperative.

When water-cariage is used, the following methods may be employed for the disposal of the sewage:—

1st. Running it into the sea, or into a tidal river, under conditions that will prevent its return,
2nd. Irrigation,
3rd. Purification by precipitation—
(*a.*)—By lime.
(*b.*)—By sulphate of alumina.
(*c.*)—By the A B C system.

The system recommended by Sir John Hawkshaw for the disposal of the Glasgow sewage is to pump it up to a high level, and to carry it down to the Ayrshire coast, and then run it into the sea. Perhaps the most serious objection to the adoption of this recommendation is, that it ignores the broad principle that the people of one river basin or drainage area should not be permitted to invade another district, in order to get rid of their sewage, but should restore it to their own river in a form sufficiently purified to prevent nuisance, and allow of the water of the river being used, to a large extent at least, for primary purposes. Apart from the enormous cost of Sir John Hawkshaw's scheme—in itself a serious obstacle to its adoption—it appears unlikely that Parliamentary sanction would be obtained in opposition to the wishes of the inhabitants of a large district with which the city of Glasgow has no connection, and to which it has no legitimate claim. The example of London in running the unpurified sewage into the Thames is scarcely one that can be followed by Glasgow. The average range of the tide in the Thames is 18 feet, while in the Clyde it is only 9 feet 9 inches: the velocity of the ebb-tide is, on the average, on the Thames 2¾ *miles*, while on the Clyde it is only 2¼ *furlongs*, or little more than one-tenth of the speed. When the sewage of London is run into the Thames at Barking and Crossness, during the first three hours of ebb-tide it passes down the river so far, before the tide flows, that it cannot return. This would not be the case in the Clyde, with its small range of tide and sluggish current; and if, therefore, the sewage of Glasgow is to be introduced into the Clyde, it must first be purified either by irrigation or precipitation.

The second method of dealing with sewage is to use it in the irrigation of land, and this system has the double advantage of purifying the water in a more complete manner than can be attained by any process of chemical treatment, and of utilising, to a certain extent, the manurial value that exists in it. Great hopes were, some years ago, entertained that irrigation was to be the grand solution of the sewage question, and companies obtained from various towns concessions of the sewage for a term of years, as if it were an article possessing an intrinsic value. All that is changed now; some sewage farms, on which immense sums of money have been expended, have been reluctantly abandoned, and irrigation is no longer regarded as anything more than a means of obtaining, where circumstances permit of its application, a good effluent at a moderate outlay. Probably Croydon—a town situated about 12 miles south, or south-east of London—has the most successful of the sewage farms, and it is no small matter to say that it disposes of the sewage of a population of 60,000 persons at an outlay which is now reduced to about £1000 per annum. But the situation of Croydon adapts it in a peculiar degree to the utilisation of its sewage by filtration through land. The quantity of water used in the town per head of population is much less than in Glasgow, and the rainfall not much more than half; no pumping is required, and land is obtained in the immediate vicinity of the town. Again, the land, although not naturally of high quality, is exceedingly well adapted for sewage farming, in consequence of its being of a loose, permeable character, with a bottom of gravel, which acts as a natural drain and prevents any accumulation of the sewage upon the surface of the ground except under very exceptional circumstances. In cold or moderate weather no odours of a distinctly offensive character are given off, but in some sewage farms, during hot weather, the odour is very disagreeable, and possibly unwholesome.

The quantity of land that appears to be necessary, under favourable circumstances, as at Croydon, is about an acre to each 100 of population, so that Glagow with its immediate suburbs would require, at the present time, fully 10 square miles of land, and, including the surrounding burghs, about 12 square miles. The greater part of the sewage would required to be pumped to a considerable height, the land (supposing it were possible to obtain it) would require to be held by the Corporation; and, as experience has shown in the case of the Barking farm, large quanties of certain crops would be obtained, which it would be impossible to dispose of to advantage. Again, it is quite certain that the land occupied could never become residential, or be occupied otherwise than by labourers engaged on the farm. This is even the case at Croydon; although, as already mentioned, the circumstances are there peculiarly favourable to sewage farming.

Purification by chemical treatment has been much misunderstood, and consequently discredited. Because it has not done all that has been claimed for it, some have been inclined to regard it as a failure, and unworthy of consideration. Several processes have been advocated for purifying sewage by precipitation, and at the same time manufacturing from the sludge obtained a manure which will be saleable at a considerable price, under the name of native guano, or some other high-sounding title. The purification of the sewage is possible, and has been carried out successfully at Bradford, Leeds, Coventry, Birmingham, and many other towns; but, so far as I have been able to ascertain, the sale of the so-called manure, except in insignificant quantities, appears to have failed of accomplishment. And this is not to be wondered at, for the precipitant, whatever it may be, while it removes the solid matter of the sewage, together with the phosphoric acid, leaves in the effluent water all or nearly all the ammonia, and the potash salts; these constituting by far the most valuable part of the sewage. All hope of making a profit by the sale of the precipitate or sludge should therefore be abandoned; but that is no reason why the process should not be adopted for the purification of sewage.

The matters removed by lime and by alumina, which are practically the only precipitants that have hitherto been employed, are—

Solid matters,
Phosphoric acid,
Fatty acids of soaps,
Nitrogenous organic matters,
Vegetable colouring matters,
Magnesia.

The soluble nitrogenous compounds and the ammonia in the effluent soon become oxidised, less rapidly in salt than in fresh water; and the oxidation is greatly facilitated by passing the purified sewage through a porous material, with free exposure to the air, or through sandy or gravelly soil.

Of all the substances proposed for precipitation, the one that appears to be most capable of general application is lime. It can be had everywhere, is cheap, and effects a sufficient purification to enable the effluent to be passed into a non-potable running stream or tidal river, especially

if the precipitation is supplemented by filtration through some form of charcoal, or by running it over a limited extent of suitable land, thoroughly drained. It has been objected to the lime process that the effluent soon decomposes, while that from other precipitants, being neutral or faintly acid, resists putrefaction for a much longer time. This is quite true, but it appears to me that the fact that the lime effluent readily oxidises is entirely in its favour. The organic matter in the purified sewage *must* be oxidised, and the sooner this is accomplished the less likely is it to produce injurious consequences.

Whatever method of precipitation be adopted, it is most important that the sludge should not remain long in the bottom of the settling tanks; whenever it is permitted to remain for a week or two it ferments, throws up bubbles of the gaseous products of decomposition, and serves to render the effluent offensive—producing, in fact, the very evils so noticeable in the harbour of Glasgow, where the solid portion of the sewage of the city settles down to the bottom, and undergoes putrefactive decomposition. The mud dredged from the Clyde, nearly opposite Lancefield, gave the following results on analysis:—

Water	11·44
Organic matter	12·31
Phosphoric acid	0·80
Sulphuric acid	0·20
Lime	1·32
Magnesia	1·30
Oxide of iron	5·23
Alumina	3·54
Sand, &c.,	63·78
	99·92
Phosphate of lime	1·74
Nitrogen	0·47
Equal to ammonia	0·57
Sulphur in organic matter and combined with iron	0·28
Calculated value, per ton	10,6

If we compare this with the sludge obtained by precipitation we will find that, except for the extra quantity of sand, there is a very striking similarity of composition.

Among the towns where precipitation is in use, none is more worthy of attention than Leicester, the population of which is about 120,000, while the sewage amounts to 7,000,000 gallons per day. It was here that the first attempt was made to purify sewage by precipitation, lime being the agent employed. After 25 years' experience, during which a great many processes were tried, the authorities came back to lime, which they consider the only possible precipitant for the sewage of a large town. The quantity of lime used is 20 to 30 cwt. per million gallons, and nothing is obtained for the sludge, which has hitherto been employed, almost exclusively, in making up land in the immediate neighbourhood of the works. The cost of working, for lime, fuel, and labour, is £2200 per annum. As regards the practical results obtained by the purification of the Leicester sewage, these are not entirely satisfactory, but the conditions existing in the town are altogether exceptional and peculiar. The river Soar, into which the effluent runs, has been canalised, and the flow is said to be only a mile a day in dry weather, while in wet weather it may be ten times as much. Then the effluent forms a very large proportion of the whole contents of the river or canal during dry weather, probably the greater part of it; and above all, there exists in the town a separate system of drains for the rainfall, and all the filth of the streets is washed into the Soar without purification. Lastly, a small low-lying part of the town has, until recently, been kept out of the general drainage system. It is therefore not surprising that, while the bed of the river is kept perfectly clean, and there is no odour perceptible in or near the town, the water four miles down is slightly offensive during dry and hot weather. The sludge, containing about 30 per cent of water, amounts to about 12,000 tons per annum. The whole of the sewage requires to be pumped 26 feet. The precipitation is effected in a series of very large tanks and settling ponds, and the effluent is further purified by filtration through an osier bed three acres in extent.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

AMERICAN CHEMICAL SOCIETY.*

THE Annual Meeting was held on December 2, 1880, Vice-President, E. R. SQUIBB, in the Chair. The following Officers were elected for 1881:—

President—Dr. C. F. Chandler.

Vice-Presidents—A. R. Leeds, E. R. Squibb, Henry Morton, G. A. Kœnig, C. A. Gœpmann.

Corresponding Secretary—P. Casamajor.

Recording Secretary—Albert H. Gallatin.

Treasurer—W. H. Nichols.

Librarian—E. Waller.

Curators—W. Rupp, A. J. Rossi, A. A. Fesquet.

Committee on Papers and Publications—Arno Behr, Gideon E. Moore, A. R. Ledoux.

Committee on Nominations—William Geyer, Jas. H. Stebbins, O. Krause, Arthur H. Elliot, J. C. Battershall.

Board of Directors—A. R. Leeds, E. R. Squibb, Henry Morton (three Local Vice-Presidents), P. Casamajor, Albert H. Gallatin, W. H. Nichols, E. Waller, A. R. Ledoux, C. F. Chandler, H. Endemann, W. M. Habirshaw, M. Alsberg, J. Goldmark.

The following gentlemen were nominated:—As Members—James T. Slade, New York City; Theo. M. Hopke, New York City; A. E. Hoppock, New York City. As Associate Member—E. K. Dunham, School of Mines, New York.

The following papers were read:—

"*On Wilkinson's Process for the Manufacture of Illuminating Gas from Wood*," by CHAS. A. DOREMUS, Ph.D., Adjunct Professor of Chemistry, Bellevue Hospital Medical College, New York. Instead of coal, heated to yield 15,000 cubic feet of gas of low candle power, Virginia pine wood of 3300 lbs. to the cord, costing 5 25 dollars delivered at and piled in the sheds, is heated in "through retorts." After the first charge the resulting charcoal is pushed back in the retort, and the gas made from the second charge is therefore obliged to traverse this bed of red-hot coal. Carbonic dioxide is changed to carbon monoxide, the water in the wood reacts to form water-gas, and a gas results free from tar, acids, &c., and having a composition of:—

Hydrogen	5·40
Marsh-gas	44·16
Carbon monoxide	33·75
Illuminants	none
Carbon dioxide	10·50
Nitrogen	6·00
Oxygen	0·25
Ammonia	none
Sulphuretted hydrogen	none
	100·00

The above is the composition of the crude gas after cooling but before purification.

The average yield during six months was 53,832 cubic feet to the cord. The coke supply for firing being deficient, the furnaces were change so as to burn "pea" anthracite. This was accomplished by using a jet of super-

* Communicated by Arthur H. Elliot, F.C.S., Recording Se

heated steam, the superheater being an iron tube running into the fire-pot, and having a central tube to convey the steam to its blind end. The returning steam found its exit through an injector into the fire. An intense heat, capable, however, of nicest regulation, was hereby attained. The air supply is obtained from an iron tube, 2 feet in diameter, open at both ends, and placed above the furnace stacks. The heated air is drawn down to the fire by the steam injector. A saving of 1 dollar per fire per diem is thus effected. Besides these advantages the wood-gas needs very little purification; the spent lime can be re-burnt at the works, the number of hands is largely diminished, and the cleanliness of the process is a notable feature.

To give the wood-gas the requisite illuminating power it is carburetted according to the "binary" process adopted at Buffalo, in 1872. The gas flows into an apparatus provided with shelves, heated by steam pipes, and meets a sheet of naphtha vapourised by the steam. The mixed gas flows from the carburetter to the "fixing retorts and a superheater together. The resulting gas needs only to be sent through a bed of charcoal to cool it and remove some little tar, and is then distributed as commercial gas. The New York Mutual Gas Company now manufacture poor coal- and wood-gas thus carburetted. The commercial gas is composed of:—

Hydrogen and Marsh-gas	56·75
Carbon monoxide	11·25
Illuminants	15·25
Carbonic dioxide	1·00
Nitrogen	15·00
Oxygen	0·75
Ammonia	—
Sulphuretted hydrogen	—
	100·00

21 volumes of wood-, 37·4 of coal-, and 41·6 of naphtha-gas make 100 of commercial gas. 4·5 gallons naphtha are required to every 1000 cub. ft. commercial gas. This gas has a candle-power of 26·53, has a gravity of 0·703 to 0·808, contains 7·28 grains of sulphur to the 100 cub. ft. (mostly CS_2), and 0·82 grain ammonia per 100 cub. ft. The analyses were made according to Wilkinson's process described in the *London Gas Light Journal*, August, 1877, with a subsequent modification for determining the nitrogen, hydrogen, and marsh-gas, given in the *American Gas Light Journal* for 1879. By this method even hourly variations in the composition of gas can be detected; it is therefore most suitable and convenient for technical purposes. The presence of nitrogen to the amount of 15 per cent, together with a light of 26·53 candle-power, is anomalous; yet the fact is certainly indisputable. The nitrogen gets access from the clay retorts from the fires, as well as by leakage. The retorts are always under exhaust to increase the yield of gas. Poor coal-gas costs 20 cts. (counting the draw-backs) per 1000, while wood-gas only costs 9·9 cts. The Mutual Company send out about 3,000,000 feet of commercial gas daily, 15 per cent being nitrogen, or 450,000 cub. ft. at 2·25 dols. per 1000 (now the ruling price in all N.Y. companies), or 1012·50 dols. profit on nitrogen per diem. The gas does not smoke, is nearly white, is of high gravity, and is constantly increasing in favour.

"*On some New Azo-Compounds*," by Jas. H. Stebbins, Jr., B.S. This paper was devoted to a description of some new dyes obtained by the author during the last few months. The first described was Orange No. 3, obtained by diazotising meta-nitraniline and combining one molecule of the diazo-compound so obtained with one molecule of beta-naphthol-disulpho-acid in an alkaline solution. Salt precipitates the dye in a yellow paste, soluble in water, and dyes wool in an acid bath of an orange colour. The reaction is as follows:—

$$C_6H_3-\overset{3}{N}O_2-\overset{1}{N}=N-\beta C_{10}H_4(NaSO_3)_2OH.$$

The next compound is Orange No. 4, produced by combining equal molecules of para-diazo-sulpho-xylol and an alkaline solution of resorcin. Hydrochloric acid precipitates the free acid as a red paste, easily soluble in water, and dyeing wool in an acid bath of an old gold colour. The formula of the body is—

$$C_6H_2(CH_3)_2\overset{4}{H}SO_3-\overset{1}{N}=N-C_6H_3(OH)_2.$$

Parazo-sulphoxyl-naphthaline-α-sulphoxyl-phenol—

$$C_{10}H_6(\overset{4}{H}SO_3)-\overset{1}{N}=N-\alpha C_6H_3(HSO_3)OH,$$

is prepared by combining equal molecules of diazo-naphthionic acid and phenole sulpho-acid in an alkaline solution; the soda salt falls from the free acid by addition of sodium chloride, as a yellow-brown paste, soluble in water.

The next body described was Parazo-dimethyl-sulphoxyl-benzol α-naphthol—

$$C_6H_2(CH_3)_2(\overset{1}{H}SO_3)-\overset{4}{N}=N-\alpha C_{10}H_6OH,$$

which is a brown dye, prepared by combining para-diazo. sulpho-xylol with an alkaline solution of α-naphthol. Hydrochloric acid gives a brown flocculent precipitate, soluble in water.

Para-diazo-sulphoxyl-β-naphthol—

$$C_6H_2(CH_3)_2(\overset{4}{H}SO_3)-\overset{1}{N}=N-\beta C_{10}H_6OH,$$

is formed as a scarlet precipitate when equal molecules of para-diazo-sulpho-xylol and β-naphthol are mixed together in an alkaline solution. The author described the soda and silver salts of this body.

The author then described Metazo-nitro-benzol-α-naphthol—

$$C_6H_4\overset{3}{N}O_2-\overset{1}{N}=N-\alpha C_{10}H_6OH,$$

produced by treating diazo-meta-nitro-benzol with an alkaline solution of α-naphthol. It is a red-brown body, soluble in water.

Also Parazo-sulphoxyl-xylol-β-phenanthrol—

$$C_6H_2(CH_3)_2(\overset{4}{H}SO_3)-\overset{1}{N}=N-\beta C_{14}H_8OH,$$

prepared by treating para-diazo-sulpho-xylol, with an alkaline solution of β-phenanthrol.

Parazo-sulphoxyl-xylol-α-dibrom-naphthol—

$$C_6H_2(CH_3)_2(\overset{4}{H}SO_3)-\overset{1}{N}=N-\alpha C_{10}H_4(Br_2)OH,$$

was prepared by treating one molecule of para-diazo-sulphoxyl with one molecule of α-dibrom-naphthol dissolved in an alkaline solution. Soluble in hot water.

Azo-dinitro-oxy-benzole-paramido-sulphoxyl-naphthalin is produced by combining equal molecules of diazo-dinitro-phenol with an alkaline solution of naphthionic acid.

Parazo-sulphoxyl-naphthalin-β-naphthol-disulpho-acid, $C_{10}H_6(HSO_3)-N=N-\beta C_{10}H_4(HSO_3)_2OH$, by the reaction of equal molecules of diazo-naphthionic acid and β-naphthol-disulpho-acid; it is a crimson dye, soluble in water.

The following papers were read by title, and referred to the Committee on Publications:—

"On Para- and Ortho-tolyl-sulpho-urethan," by C. Liebermann and S. Natanson.

"On Compounds of Anthracen with Different Oxides of Nitrogen," by C. Liebermann and L. Lindermann.

"On the Composition of Æsculine and Æsculetine," by C. Liebermann and R. Kneitsch.

"Investigations on the Reduction of Anthraquinone," by C. Liebermann.

"On the Electrolytic Determination of Silver," by H. Fresenius and F. Bergmann.

"On the Electrolytic Determination of Nickel and Cobalt," by H. Fresenius and F. Bergmann.

"On Cyanethine and New Bases Derived therefrom," by Ernst von Meyer.

CORRESPONDENCE.

BLEACHING-POWDER.

To the Editor of the Chemical News.

SIR,—The reply given by Dr. Lunge to my previous letter makes it necessary for me—with your permission—to enter a little more into the details of the subject in question.

On reading Dr. Lunge's paper, printed in the CHEMICAL NEWS (vol. xliii., p. 1), it occurred to me that the author should have treated of the existence of calcic hypochlorite in solutions of "bleach" rather as an ascertained fact than as a mere assumption made by most chemists; and as I had previously isolated the crystallised hypochlorite from such solutions, I felt that such a treatment of the matter was due to me, apart from the manner in which my experiments affect the views regarding the constitution of bleaching-powder.

I entertain a great respect for the opinions of Dr. Lunge, but I object to the manner in which he refers to the particular investigation alluded to previously. That the solutions of bleaching-powder examined by me contained and yielded calcic hypochlorite is not merely my opinion, but is an absolutely proven fact. Specimens of the crystallised salt were exhibited at the Chemical Society, and the details of the analytical methods employed, together with the results obtained, are stated in my paper (*Journ. Chem. Soc.*, May, 1875). Subsequently, a further quantity, nearly a pound by weight, of the calcic hypochlorite was obtained from another sample of bleaching-powder, and some of this, changed though it may be, is still in my laboratory. It is true that in my paper I expressed the desirability of other chemists repeating the observations upon further samples of bleaching-powder, but I made no apology for such observations as I had recorded, and I make no apology now. The expression referred to neither detracted from the force of my convictions nor prejudiced in any way the fact that different samples of bleaching-powder examined by me yielded in contact with water calcic hypochlorite which was crystallised out of the aqueous solutions.

The doubt that was really in my mind was clearly stated in the CHEMICAL NEWS, when my paper was reprinted therein with some additional notes (vol. xxxii., p. 22), and concerned the possibility of the non-identity of the crystals which sometimes form in frozen solutions of bleach with those obtained as otherwise described, and which alone had been analysed.

That Dr. Lunge has failed to obtain calcic hypochlorite by repeating my observations seems strange to me, because the proceedings are so simple, and I can assure him that there are no such conditions to be observed as hinted at by him. Will he kindly state for how long he allowed the bleach solutions to remain *in vacuo* over sulphuric acid and caustic potash, and will he have the goodness to favour me with a small quantity of the "bleach" from which he failed to obtain the crystals? This concerns an important matter, and it is one which deserves to be thoroughly worked out.

A few words, now, as regards the other point in this discussion. As I read the history of bleaching-powder, taking note of all recorded observations, chemists are forced to choose between Gay-Lussac's and Odling's formulæ. The former of these assumes the co-existence of calcic hypochlorite and calcic chloride in bleaching-powder, but since the last-named substance cannot be separated therefrom, there is no reliable ground for belief in its correctness. If Odling's formula represents "bleach" as the unitary compound Cl—Ca—OCl; and if bleaching-powder suffers decomposition in a state of aqueous solution at all, I fail to see how else it can split up than into hypochlorite and chloride. That this decomposition occurs has been assumed by most chemists for a long time, and the proof of the decomposition was furnished by my investigation. I therefore abide by what is stated in my "Alkali Trade," p. 182, viz., that "the combination

$$\left(Ca\begin{cases}Cl\\OCl\end{cases}\right)$$

is so feeble that under certain conditions water destroys the compound from a chemical whole into the two salts." Incidentally proof is furnished of the correctness of Odling's formula; and if further corroboration be needed I think it would be most easily found in the study of the action of dilute acids upon solutions of bleaching-powder, and in the further study of the action of chlorine upon milk of lime.—I am, &c.,

C. T. KINGZETT.

12, Auriol Road, West Kensington, W.,
January 29, 1881.

SOCIETY OF INDUSTRIAL CHEMISTS.

To the Editor of the Chemical News.

SIR,—Will you kindly allow me to ask through your columns, what has become of the projected Technical Society? (*Vide* CHEMICAL NEWS, vol. xli., pp. 243 and 261). Has the comittee given up the idea? If so, it devolves upon those directly interested in the scheme to see that it is not allowed to fall into oblivion. Surely there are technical chemists enough to render such an amount of support as to ensure success to such an undertaking.

Trusting soon to receive some information as to what has been the result of the committee's investigations,—I am, &c.

J. H.

January 29, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 1, January 3, 1880.

Magnetic Oxide of Iron.—M. Berthelot.—The author has determined the formation-heat of the most soluble variety of the magnetic oxide of iron. He finds that the heat liberated on the combination of the two primary oxides of iron, the ferrous and ferric, amounts to 4·4 cals.

Measurement of the Electromotor Force of Batteries.—J. B. Baille.—The following numbers represent the potential of an element of the battery, that is to say, the quantity of electricity which the pole of this battery diffuses in a sphere of 0·01 m. radius. They are expressed in electric unities, the unity being the quantity of electricity which, reacting upon itself at the distance of 0·01 m., produces a repulsion = 1 grm. Volta's battery, 0·03415; zinc, copper sulphate, copper, 0·02997; zinc, acidulated water, copper, copper sulphate, 0·03709; zinc, salt-water, coke, manganese peroxide, 0·05282; zinc, salt-water, platinum, platinum chloride, 0·05027; zinc, acidulated water, coke, nitric acid, 0·06285. These figures are the maximum values obtained at the moment when the battery is charged, but these potentials diminish rapidly with time.

Speed of Light.—Reply to M. Cornu.—M. Gouy.—Not suitable for abstraction.

Study on Spectro-photometers.—A. Crova.—The comparison of two spectra coming from two different sources of light is easily effected by covering the half of the slit of a photometric spectroscope with a small rectangular prism, the edge of which cuts the slit normally into

two equal parts; one of its halves receives one of the lights directly, whilst the other receives by reflection the other light placed laterally. In this case the slit should be horizontal, and if the prisms are well cut and free from aberration, we obtain at once the distinct image of the spectral rays and that of the edge of the prism, which appears as a fine line, separating from each other the two spectra to be compared.

Process for Reproducing Words with Electric Condensers, and especially with the Singing Condenser.—A. Dunand.—In order to make a condenser sing it is merely needful to connect its armatures with the extremities of the secondary helix of an induction-coil, interposing in the primary helix a battery and a microphone analogous to the transmitter of Reiss. If thus arranged the apparatus merely reproduces musical sounds. The author interposed a battery in the secondary helix of the coil, *i.e.*, he connected one extremity of the induced wire with one of the poles of a battery, the other pole communicating with one armature of the condenser, the second armature being attached to the other extremity of the induced wire. Articulate sounds are then reproduced with perfect distinctness. M. Th. du Moncel observed that this fact confirms his ideas on the origin of sounds in the telephone.

Vapour-Density of Iodine.—J. M. Crafts and F. Meier.—The authors remark that at a low temperature, *e.g.*, at 355° the vapours of iodine have the same coefficient of expansion and compressibility as the air. The variation of the density with rising temperature increases rapidly and then decreases, becoming *nil* at the highest temperatures. With low tensions the vapour-density becomes constant again between 1400° to 1520°, and equal to the half of the normal density. The softening of the porcelain by heat prevented the authors from carrying this investigation to a conclusion in the case of higher pressures. As regards theoretical conclusions, all the facts agree with the hypothesis already advanced that iodine may exist at low temperatures in the molecular state, I_2, and at higher temperatures in the atomic state, I, the variations of density with temperature and pressure corresponding with a dissociation which progresses according to laws often observed. When we come to the question of the dissociation of a molecule into homogeneous atoms we cannot employ the methods of demonstration which M. Sainte-Claire Deville made use of, and it must be admitted that absolute proof is wanting. But we cannot fail to recognise that all the phenomena take place as if a dissociation took place, and this hypothesis seems to us to offer the sole explanation of the curious fact that the two limits correspond with two simple and well-defined chemical proportions, I_2 and I. The effect of a decrease of tension in facilitating dissociation is well-known. M. Salet has observed that the colour of the vapours of iodine becomes much less intense at high temperatures. The authors hope that their researches may furnish a numerical basis of the speculations on the decomposition of the elements which have been founded on spectroscopic observations.

Direct Preparation of the Chloro- and Bromo-Compounds of the Methylic Series, and Especially of Chloroform and Bromoform.—M. Alb. Damoiseau.—The author allows a regular current of chlorine, furnished by a continuous apparatus, to mix in suitable proportions with methyl-chloride, and then to traverse a long tube containing animal charcoal and heated to 250° to 350°. The gases are washed with water to remove hydrochloric acid and refrigerated. In this manner many hundred grammes of chloroform may be prepared.

Facts Towards the Study of the Formation of Fog.—M. Ch. André.—The author records an observation made at Mount Verdun, on Nov. 8 last. During the day the barometer was high, the temperature about 0°, and the wind blew with a feeble mean pressure. An intense fog covered the table-land o Verdun, occasionally dispersing to reappear after a short interval. The barometer fell whenever rain set in, but the fall was always sudden and generally accompanied by the dispersal of the fog. The rise was more gradual and was accompanied by the reappearance of the fog.

A New Use of Electricity.—M. O. F. Grandt.—The author has constructed an apparatus for giving movement to ships. An ordinary steam-engine sets in action one or more electro-dynamic induction machines. The current is transmitted to a voltameter containing acidulated water which is decomposed into oxygen and hydrogen. These gases are conducted into a tube and escape by an aperture near the keel. A little above this aperture there are two platinum points isolated from each other and in communication with a Ruhmkorff's induction coil. When the gas escapes, a spark explodes it, and this explosion moves the ship.

Journal de Pharmacie et de Chimie.
August, 1880.

Curare of English Guiana.—G. Planchon.—A conclusion of the papers on the strychnos.

Absence of Mercury in the Mineral Waters of the Springs of Rocher and Saint Nectaire.—J. Lefort.—A lengthy paper, of doubtful scientific importance.

Wines made from Dry Grapes.—M. Reboul.—There is no absolute chemical distinction between natural wines and those made from raisins.

Report Submitted by M. Riche to the Academy o Medicine on the Substitution of Margarine for Butter and Lard in the Public Asylums of the Department of the Seine.—The author concludes that there are no grounds for the substitution of margarine for butter.

Preparation of Malonic Acid.—E. Bourgoin.

Synthesis of Citric Acid.—E. Grimaux and P. Adam.

Detection and Determination of Heavy Mineral Oils, Fatty Oils, and Resin in the Oils of Commerce (Second part).—A. Semont.—These three papers have been already noticed.

Die Chemische Industrie.
No. 7, July, 1880.

The German Alkali Trade in 1880.—R. Hasenclever.—This memoir is rather commercial and protectionist than technological. He expects that the importation of foreign soda into Germany will soon cease, and that over-production will set in. He then criticises some of the recent improvements described in Dr. Lunge's work.

Analyses of Leblanc's Crude Soda and of Soda-lyes in Different Stages of Preparation.—Dr. K. W. Jurische.—The writer maintains that the quantity of the cyanogen compounds depends simply on the quantity of undecomposed sulphate present. The advantage of the Pechiney-Weldon process is chiefly in the circumstance that a product is always obtained containing approximately the same proportion of undecomposed sulphate, which is sufficient to keep down the cyanides to the proportion which occurs in hand-made lyes.

No. 8, August, 1880.

Colorimetric Determination of Chlorine in Potassium Bromide.—Dr. Carl Roth.—If potassium bromide containing chlorine is distilled with sulphuric acid and potassium chromate and the chromium oxychloride evolved is passed into water containing ammonia, it is known to be resolved into ammonium chloride, water, and ammonium chromate. Since the dilute solutions of neutral ammonium chromate display very decided differences in intensity of colour, there is here the possibility of using this colour to indicate the percentage of chlorine in the potassium bromide. For this purpose exactly 1 grm. potassium bromide is ground up to a powder with approxi-

mately the same quantity of potassium bichromate, and the mixture is introduced without loss into a small flask, where it is drenched with about 5 c.c. concentrated sulphuric acid. The flask is then connected by means of a tube ground so as to fit air-tight with a receiver containing 50 c.c. of very dilute ammonia. All the chlorine is driven over by the application of a gentle heat as chromium oxychloride, which is decomposed on entering the receiver in the ordinary manner. A regurgitation of the ammoniacal liquid into the flask is prevented by means of two balls blown on the connecting tube After the completion of the operation the contents of the receiver are introduced into a measuring cylinder, and diluted with water to 100 c.c. For comparison, there are used solutions of neutral ammonium chromate of known strength; 152 parts of ammonium chromate correspond to 71 parts of chlorine. If we suppose a maximum quantity of chlorine as 5 per cent, or 0·107 grm. in 1 grm. potassium bromide, there follows from the proportion 71 : 152 = 0·05 : x = 0·107 grm. ammonium chromate, which must be dissolved in 100 c.c. water in order to obtain a colour representing 5 per cent. In a similar manner solutions may be prepared representing smaller proportions.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 6, 1880.

New Electrolytic Results.—E. F. Smith.—On passing the current from a potassium chromate battery of two elements through an aqueous solution of uranium acetate, bright yellow uranium sesquioxide was separated at the zinc pole and gradually turned black. No uranium remained in the solution. The most favourable results were obtained on dissolving 1000 grms. of a salt of uranium in 10 c.c. water. The complete precipitation of the uranium and its conversion into the black form requires three hours. The black compound is uranic uranous oxide, containing 81·13 per cent of metallic uranium. This process is well adapted for the analysis of the uranium silicates. Ammonium molybdate is precipitated by the current, but the process requires many hours for its completion. Neutral solutions of tungstates are not affected by the current. If boiled with acetic acid there is produced a small quantity of a blue precipitate, which turns brown on prolonged action, but becomes blue again on exposure to the air. In solutions of the vanadiates the current produces only a change of colour. Vanadium sulphate yields a deposit of small, deep brown flakes. Didymium is imperfectly precipitated at the positive pole. From the salts of cerium the yellow Ce_3O_4 hydrate is thrown down, incompletely and slowly.

The Colouring-Matter of Alkanet (Anchusa tinctoria) as a Reagent for Magnesium Salts.—F. v. Lepel.

Vegetable Colouring-Matters as Reagents for Magnesium Salts.—F. v. Lepel.—These two papers require the accompanying diagrams.

An Acoustic Method of Determining Vapour-Densities.—H. Goldschmiedt.

A New Apparatus for the Volumetric Determination of Nitrogen.—H. Schwarz.—These two memoirs cannot be usefully reproduced without the accompanying illustrations.

Bulletin de la Société Chimique de Paris.
No. 1, July 20, 1880.

Density of the Vapour of Iodine.—J. M. Crafts and F. Meier.—In this paper, which is a continuation from pp. 501 and 550 of vol. 33, the authors describe their method for the determination of the temperatures which they communicated to the Academy of Sciences (March 15, 1880), and which is the same as that employed by Prof. Meyer in his recent investigation on gaseous chlorine.

Certain Compounds of the Halogens.—M. Berthelot.—A thermo-chemical paper, already noticed.

Separation of Cadmium and Zinc.—A. Yver.—In a memoir inserted in the *Annales de Chimie et de Physique* (Series 4, vol. 30, p. 351), M. Riche described a process for the determination of zinc, either by the decomposition of the acetate or by the electrolysis of the solution containing sulphuric acid. Several researches on the same subject have since been published by different authors. MM. Beilstein and Jawein, whilst confirming the results of Riche, employ the following process:—The nitric or sulphuric solution of zinc is mixed with caustic soda until precipitation ensues, and then with potassium cyanide till the precipitate is re-dissolved; the electrolysis is then effected with four Bunsen elements. The determination of cadmium has been effected by the same chemists under the same circumstances by means of the current from three elements. M. Millot has recently given a process for the determination of zinc by the electrolysis of a solution of this metal in potassa. M. Edgar Smith obtains a precipitate of metallic cadmium by passing a strong current through a solution of the acetate. These procedures have the defect of not serving for the separation of cadmium and zinc, as the two metals are precipitated simultaneously. They may be separated as follows:—The solution containing the two metals in the state of acetates is mixed with 2 or 3 grms. sodium acetate, and a few drops of acetic acid. The current from two Daniell elements is then passed through the solution as described by M. Riche in his memoir. The cadmium alone is deposited in a crystalline layer at the negative pole, the zinc remaining in solution. The process requires the aid of heat, and requires three to four hours for quantities of 0·180 grm. to 0·210 grm. cadmium, and as much zinc. The deposit is effected in the crucible, and the liquid is then drawn off and serves for the determination of the zinc, according to M. Riche's process. The deposit is washed first with water, then with alcohol, dried, and weighed. If the zinc and cadmium are present as sulphates the author recommends precisely the same method. Or the sulphuric solution may be mixed with ammonia and ammonium sulphate.

Reproduction of Analcime.—A. de Schulten.—Already noticed.

Compounds of Uranium with the Alkaline Pyrophosphates and Meta-phosphates.—P. Chastaing.—Not capable of useful abstraction.

Sodium Boro-tungstates.—D. Klein.—The author adds small successive portions of tungstic acid to a boiling solution of borax. On cooling boracic acid and sodium, poly-borates crystallise out, and on concentration the mother-liquor deposits sodium boro-tungstate in bacillary crystals, soluble in one-fourth their weight of water, and which may be represented by the formula—

$$10WO_3.Bo_2O_3,2Na_2O + 11aq.$$

Preparation of Sulphuric Ether.—A. Villiers.—Already noticed.

Preparation of Hydrochloric Ether.—A. Villiers.—The author passes hydrochloric gas into boiling absolute alcohol contained in a flask fitted with an ascending refrigerator.

Formation of the Bromised Derivatives of Ethyl Bromide in the Preparation of Hydrobromic Ether.—A. Bertrand and E. Finot.—The authors have obtained a bromised ethyl bromide boiling at 110°, another boiling at 180°, and a dibromised ethylene dibromide boiling at 195° to 200°.

Dichloro-lactic Acid.—E. Grimaux and P. Adam.—This compound is obtained by the action of hydrocyanic and hydrochloric acids upon dichloric aldehyd. It forms transparent laminæ, fusible at 76·5° to 77°; very soluble in water, alcohol, and ether, of the composition—

$$C_3H_4Cl_2O_3.$$

Tetric and Oxy-tetric Acids and their Homologues (Concluded from pp. 516 and 575).—E. Demarçay.—Not suitable for abstraction.

MISCELLANEOUS.

Sanitary Institute of Great Britain.—At a meeting of the Sanitary Institute of Great Britian, held January 27, B. W. Richardson, M.D., F.R.S., in the chair, the Secretary read a list of books presented to the library since last meeting, and one Fellow and two Members were elected.

MEETINGS FOR THE WEEK.

MONDAY, 7th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Institution, General Monthly Meeting, 5.
—— Society of Arts, 8. "Watchmaking," by Edward Rigg, M.A.
TUESDAY, 8th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
WEDNESDAY, 9th.—Society of Arts, 8. "The Present Condition of the Art of Wood-carving in England," J. Hungerford Pollen.
—— Microscopical, 8. (Anniversary), 9.
—— Royal Institution, 3. "The Amazons," Prof. S. Colvin.
THURSDAY, 10.h.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Royal Institution, 3. "The Troubadours," Mr. F. Huefler.
FRIDAY, 11th.—Royal Institution, 8. "Distance of the Stars," Prof. R. S. Ball, 9.
—— Quekett, 8.
—— Society of Arts, 8. "The Gold Fields of India," Hyde Clarke.
SATURDAY, 12th.—Royal Institution, 3. "The Amazons," Prof. S. Colvin.
—— Physical, 3. Annual General Meeting. Special General Meeting. "On a Hydrostatic Illustration of Electrical Phenomena and other Lecture Experiments," Dr. O. J. Lodge.

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Town Hall, Salford, 21st January, 1881.

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8th January, 1881.

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AND
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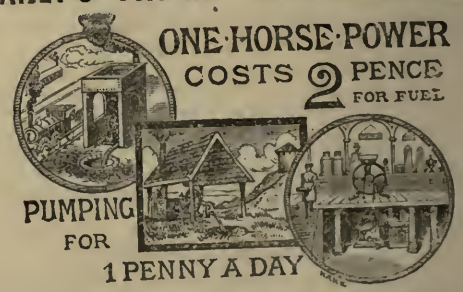

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1107.

ACTION OF AN INTERMITTENT BEAM OF RADIANT HEAT UPON GASEOUS MATTER.*

By JOHN TYNDALL, F.R.S.

The Royal Society has already done me the honour of publishing a long series of memoirs on the interaction of radiant heat and gaseous matter. These memoirs did not escape criticism. Distinguished men, among whom the late Prof. Magnus and the late Prof. Buff may be more specially mentioned, examined my experiments, and arrived at results different from mine. Living workers of merit have also taken up the question: the latest of whom,† while justly recognising the extreme difficulty of the subject, and while verifying, so far as their experiments reach, what I had published regarding dry gases, find me to have fallen into what they consider grave errors in my treatment of vapours.

None of these investigators appear to me to have realised the true strength of my position in its relation to the objects I had in view. Occupied for the most part with details, they have failed to recognise the stringency of my work as a whole, and have not taken into account the independent support rendered by the various parts of the investigation to each other. They thus ignore verifications, both general and special, which are to me of conclusive force. Nevertheless, thinking it due to them and me to submit the questions at issue to a fresh examination, I resumed, some time ago, the threads of the inquiry. The results shall, in due time, be communicated to the Royal Society; but, meanwhile, I would ask permission to bring to the notice of the Fellows a novel mode of testing the relations of radiant heat to gaseous matter, whereby singularly instructive effects have been obtained.

After working for some time with the thermopile, it occurred to me several weeks ago that the results thus obtained might be made evident by a more direct and simple form of experiment. Placing the gases and vapours in diathermanous bulbs, and exposing the bulbs to the action of radiant heat, the heat absorbed by different gases and vapours ought, I consider, to be rendered evident by ordinary expansion. I devised an apparatus with a view of testing this idea. But, at this point, and before my proposed gas-thermometer was constructed, I became aquainted with the ingenious and original experiments of Mr. Graham Bell, wherein musical sounds are obtained through the action of an intermittent beam of light upon solid bodies.

From the first, I entertained the opinion that these singular sounds were caused by rapid changes of temperature producing corresponding changes of shape and volume in the bodies impinged upon by the beam. But if this be the case, and if gases and vapours really absorb radiant heat, they ought to produce sounds more intense than those obtainable from solids. I pictured every stroke of the beam responded to by a sudden expansion of the absorbent gas, and concluded that when the pulses thus excited followed each other with sufficient rapidity, a musical note must be the result. It seemed plain, moreover, that by this new method many of my previous results might be brought to an independent test. Highly diathermanous bodies, I reasoned, would produce faint sounds, while highly athermanous bodies would produce loud sounds; the strength of the sound being, in a sense, a measure of the absorption. The first experiment made, with a view of testing this idea, was executed in the presence of Mr. Graham Bell;* and the result was in exact accordance with what I had foreseen.

The inquiry has been recently extended so as to embrace most of the gases and vapours employed in my former researches. My first source of rays was a Siemens lamp connected with a dynamo-machine, worked by a gas engine. A glass lens was used to concentrate the rays, and afterwards two lenses. By the first the rays were rendered parallel, while the second caused them to converge to a point about 7 inches distant from the lens. A circle of sheet zinc provided first with radial slits and afterwards with teeth, cut through it, was mounted vertically on a whirling table, and caused to rotate rapidly across the beam near the focus. The passage of the slits produced the desired intermittence,† while a flask containing the gas or vapour to be examined received the shocks of the beam immediately behind the rotating disk. From the flask a tube of india-rubber, ending in a tapering one of ivory or box wood, led to the ear, which was thus rendered keenly sensitive to any sound generated within the flask. Compared with the beautiful apparatus of Mr. Graham Bell, the arrangement here described is rude; it is, however, very effective.

With this arrangement the number of sounding gases and vapours was rapidly increased. But I was soon made aware that the glass lenses withdrew from the beam its most effectual rays. The silvered mirrors employed in my previous researches were therefore invoked; and with them, acting sometimes singly and sometimes as conjugate mirrors, the curious and striking results which I have now the honour to submit to the Society were obtained.

Sulphuric ether, formic ether, and acetic ether being placed in bulbous flasks,‡ their vapours were soon diffused in the air above the liquid. On placing these flasks, whose bottoms only were covered by the liquid, behind the rotating disk, so that the intermittent beam passed through the vapour, loud musical tones were in each case obtained. These are known to be the most highly absorbent vapours which my experiments revealed. Chloroform and bisulphide of carbon, on the other hand, are known to be the least absorbent, the latter standing near the head of diathermanous vapours. The sounds extracted from these two substances were usually weak and sometimes barely audible, being more feeble with the bisulphide than with the chloroform. With regard to the vapours of amylene, iodide of ethyl, iodide of methyl and benzol, other things being equal, their power to produce musical tones appeared to be accurately expressed by their ability to absorb radiant heat.

It is the vapour, and not the liquid, that is effective in producing the sounds. Taking, for example, the bottles in which my volatile substances are habitually kept, I permitted the intermittent beam to impinge upon the liquid in each of them. No sound was in any case produced, while the moment the vapour-laden space above an active liquid was traversed by the beam, musical tones made themselves audible.

A rock-salt cell filled entirely with a volatile liquid, and subjected to the intermittent beam, produced no sound. This cell was circular and closed at the top. Once, while

* A paper read before the Royal Society, January 13, 1881.

† MM. Lecher and Pernter, *Philosophical Magazine*, January, 1881. *Sitzb. der K. Akad. der Wissensch. in Wein*, July, 1880.

* On the 29th November: see *Journal of the Society of Telegraph Engineers*, December 8, 1880.

† When the disk rotates the individual slits disappear, forming a hazy zone through which objects are visible. Throwing by the clean hand, or better still by white paper, the beam back upon the disk, it appears to stand still, the slits forming so many dark rectangles. The reason is obvious, but the experiment is a very beautiful one.

I may add that when I stand with open eyes in the flashing beam, at a definite velocity of recurrence, subjective colours of extraordinary gorgeousness are produced. With slower or quicker rates of rotation the colours disappear. The flashes also produce a giddiness sometimes intense enough to cause me to grasp the table to keep myself erect.

‡ I have employed flasks measuring from 8 inches to ¾ths of an inch in diameter. The smallest flask, which had a stem with abore of about ⅛th of an inch in diameter, yielded better effects than the largest. Flasks from 2 to 3 inches in diameter, yield good results. Ordinary test-tubes also answer well.

operating with a highly athermanous substance, a distinct musical note was heard. On examining the cell, however, a small bubble was found at its top. The bubble was less than a quarter of an inch in diameter, but still sufficient to produce audible sounds. When the cell was completely filled, the sounds disappeared.

It is hardly necessary to state that the pitch of the note obtained in each case is determined by the velocity of rotation. It is the same as that produced by blowing against the rotating disk and allowing its slits to acts like the perforations of a syren.

Thus, as regards vapours, prevision has been justified by experiment. I know turn to gases. A small flask, after having been heated in the spirit-lamp so as to detach all moisture from its sides, was carefully filled with dried air. Placed in the intermittent beam it yielded a musical note, but so feeble as to be heard only with attention. Dry oxygen and hydrogen behaved like dry air. This agrees with my former experiments, which assigned a hardly sensible absorption to these gases. When the dry air was displaced by carbonic acid, the sound was far louder than that obtained from any of the elementary gases. When the carbonic acid was displaced by nitrous oxide, the sound was much more forcible still, and when the nitrous oxide was displaced by olefiant gas it gave birth to a musical note, which when the beam was in good condition, and the bulb well chosen, seemed as loud as that of an ordinary organ pipe.* We have here the exact order in which my former experiments proved these gases to stand as absorbers of radiant heat. The amount of the absorption and the intensity of the sound go hand in hand.

A soap bubble blown with nitrous oxide, or olefiant gas, and exposed to the intermittent beam, produced no sound, no matter how its size might be varied. The pulses obviously expended themselves upon the flexible envelope, which transferred them to the air outside.

But a film thus impressionable to impulses on its interior surface, must prove at least equally sensible to sonorous waves impinging on it from without. Hence, I inferred, the eminent suitability of soap bubbles for sound lenses. Placing a "sensitive flame" some feet distant from a small sounding reed, the pressure was so arranged that the flame burnt tranquilly. A bubble of nitrous oxide (sp. gr. 1·527) was then blown, and placed in front of the reed. The flame immediately fell and roared, and continued agitated as long as the lens remained in position. A pendulous motion could be imparted to the bubble so as to cause it to pass to and fro in front of the reed. The flame responded, by alternately roaring and becoming tranquil, to every swing of the bubble. Nitrous oxide is far better for this experiment than carbonic acid, which speedily ruins its envelope.

The pressure was altered so as to throw the flame, when the reed sounded, into violent agitation. A bubble blown with hydrogen (sp. gr. 0·069) being placed in front of the reed, the flame was immediately stilled. The ear answers instead of the flame.

In 1859 I proved gaseous ammonia to be extremely impervious to radiant heat. My interest in its deportment when subjected to this novel test was therefore great. Placing a small quantity of liquid ammonia in one of the flasks, and warming the liquid slightly, the intermittent beam was sent through the space above the liquid. A loud musical note was immediately produced. By the proper application of heat to a liquid the sounds may be always intensified. The ordinary temperature, however, suffices in all the cases thus far referred to.

In this relation the vapour of water was that which interested me most, and as I could not hope that at ordinary temperatures it existed in sufficient amount to produce audible tones, I heated a small quantity of water in a flask almost up to its boiling-point. Placed in the intermittent beam, I heard—I avow with delight—a powerful musical sound produced by the aqueous vapour.

Small wreaths of haze, produced by the partial condensation of the vapour in the upper and cooler air of the flask, were, however, visible in this experiment; and it was necessary to prove that this haze was not the cause of the sound. The flask was, therefore, heated by a spirit-flame beyond the temperature of boiling water. The closest scrutiny by a condensed beam of light then revealed no trace of cloudiness above the liquid. From the perfectly invisible vapour, however, the musical sound issued, if anything, more forcible than before. I placed the flask in cold water until its temperature was reduced from about 90° to 10° C., fully expecting that the sound would vanish at this temperature; but, notwithstanding the tenuity of the vapour, the sound extracted from it was not only distinct but loud.

Three empty flasks, filled with ordinary air, were placed in a freezing mixture for a quarter of an hour. On being rapidly transferred to the intermittent beam, sounds much louder than those obtainable from dry air were produced.

Warming these flasks in the flame of a spirit-lamp until all visible humidity had been removed, and afterwards urging dried air through them, on being placed in the intermittent beam the sound in each case was found to have fallen almost to silence.

Sending, by means of a glass tube, a puff of breath from the lungs into a dried flask, the power of emitting sound was immediately restored.

When, instead of breathing into a dry flask, the common air of the laboratory was urged through it, the sounds became immediately intensified. I was by no means prepared for the extraordinary delicacy of this new method of testing the athermancy and diathermancy of gases and vapours, and it cannot be otherwise than satisfactory to me to find that particular vapour, whose alleged deportment towards radiant heat has been so strenuously denied, affirming thus audibly its true character.

After what has been stated regarding aqueous vapour, we are prepared for the fact that an exceedingly small percentage of any highly athermanous gas diffused in air suffices to exalt the sounds. An accidental observation will illustrate this point. A flask was filled with coal-gas and held bottom upwards in the intermittent beam. The sounds produced were of a force corresponding to the known absorptive energy of coal-gas. The flask was then placed upright, with its mouth open, upon a table, and permitted to remain there for nearly an hour. On being restored to the beam the sounds produced were far louder than those which could be obtained from common air.*

Transferring a small flask or a test-tube from a cold place to the intermittent beam, it is sometimes found to be practically silent for a moment, after which the sounds become distinctly audible. This I take to be due to the vapourisation by the calorific beam of the thin film of moisture adherent to the glass.

My previous experiments having satisfied me of the generality of the rule that volatile liquids and their vapours absorb the same rays, I thought it probable that the introduction of a thin layer of a liquid, from which even a most energetic vapour was derived, would detach the effective rays, and thus quench the sounds. The experiment was made, and the conclusion verified. A layer of water, formic ether, sulphuric ether, or acetic ether, one-eighth of an inch in thickness, rendered the transmitted beam powerless to produce any musical sound. These liquids being transparent to light, the efficient rays which they intercepted must have been those of obscure heat.

A layer of bisulphide of carbon about ten times the thickness of the transparent layers just referred to, and rendered opaque to light by dissolved iodine, was interposed in the path of the intermittent beam. It produced hardly any diminution of the sounds of the more active

* With conjugate mirrors the sounds with olefiant gas are readily obtained at a distance of twenty yards from the lamp. I hope to be able to make a candle flame effective in these experiments.

* The method here described is, I doubt not, applicable to the detection of extremely small quantities of fire-damp in mines.

vapours—a further proof that it is the invisible heat rays, to which the solution of iodine is so eminently transparent, that are here effectual.

Converting one of the small flasks used in the foregoing experiments into a thermometer bulb, and filling it with various gases in succession, it was found that with those gases which yielded a feeble sound, the displacement of a thermometric column associated with the bulb was slow and feeble, while with those gases which yielded loud sounds, the displacement was prompt and forcible.

Further Experiments.

Since the handing in of the foregoing note, on the 3rd of January, the experiments have been pushed forward; augmented acquaintance with the subject serving only to confirm my estimate of its interest and importance.

All the results described in my first note have been obtained in a very energetic form with a battery of sixty Grove's cells.

On the 4th of January I chose for my source of rays a powerful lime-light, which, when sufficient care is taken to prevent the pitting of the cylinder, works with admirable steadiness and without any noise. I also changed my mirror for one of shorter focus, which permitted a nearer approach to the source of rays. Tested by this arrrangement the stronger vapours rose remarkably in sounding power.

Improved manipulation was, I considered, sure to extract sounds from rays of much more moderate intensity than those of the lime-light. For this light, therefore, a common candle flame was substituted. Received and thrown back by the mirror, the radiant heat of the candle produced audible tones in all the stronger vapours.

Abandoning the mirror and bringing the candle close to the rotating disk, its direct rays produced audible sounds.

A red-hot coal, taken from the fire and held close to the rotating disk, produced forcible sounds in a flask at the other side.

A red-hot poker, placed in the position previously occupied by the coal, produced strong sounds. Maintaining the flask in position behind the rotating disk, amusing alternations of sound and silence accompanied the alternate introduction and removal of the poker.

The temperature of the iron was then lowered till its heat just ceased to be visible. The intermittent invisible rays produced audible sounds.

As might be expected from the foregoing experiments, an incandescent platinum spiral, with or without the mirror, produced musical sounds. When the battery power was reduced from ten cells to three, the sounds, though enfeebled, were still distinct.

My neglect of aqueous vapour had led me for a time astray in 1859, but before publishing my results I had discovered my error. On the present occasion this omnipresent substance had also to be reckoned with. Fourteen flasks of various sizes, with their bottoms covered with a little sulphuric acid, were closed with ordinary corks and permitted to remain in the laboratory from the 23rd of December to the 4th of January. Tested on the latter day with the intermittent beam, half of them emitted feeble sounds, but half were silent. The sounds were undoubtedly due not to dry air, but to traces of aqueous vapour.

An ordinary bottle, containing sulphuric acid for laboratory purposes, being connected with the ear and placed in the intermittent beam, emitted a faint, but distinct, musical sound. This bottle had been opened two or three times during the day, its dryness being thus vitiated by the mixture of a small quantity of common air. A second similar bottle, in which sulphuric acid had stood undisturbed for some days, was placed in the beam: the dry air above the liquid proved absolutely silent.

On the evening of January 7th Prof. Dewar handed me four flasks treated in the following manner:—Into one was poured a small quantity of strong sulphuric acid; into another a small quantity of Nordhausen sulphuric acid; in a third were placed some fragments of fused chloride of calcium; while the fourth contained a small quantity of phosphoric anhydride. They were closed with well-fitting india-rubber stoppers, and permitted to remain undisturbed throughout the night. Tested after twelve hours, each of them emitted a feeble sound, the flask last mentioned being the strongest. Tested again six hours later, the sound had disappeared from three of the flasks, that containing the phosphoric anhydride alone remaining musical.

Breathing into a flask partially filled with sulphuric acid instantly restores the sounding power, which continues for a considerable time. The wetting of the interior surface of the flask with the sulphuric acid always enfeebles, and sometimes destroys, the sound.

A bulb, less than a cubic inch in volume, and containing a little water, lowered to the temperature of melting ice, produces very distinct sounds. Warming the water in the flame of a spirit-lamp, the sound becomes greatly augmented in strength. At the boiling temperature the sound emitted by this small bulb* is of extraordinary intensity.

These results are in complete accord with those obtained by me nearly nineteen years ago, both in reference to air and to aqueous vapour. They are in utter disaccord with those obtained by other experimenters, who have ascribed a high absorption to air and none to aqueous vapour.

The action of aqueous vapour being thus revealed, the necessity of thoroughly drying the flasks, when testing other substances, becomes obvious. The following plan has been found effective:—Each flask is first heated in the flame of a spirit-lamp till every visible trace of internal moisture has disappeared, and it is afterwards raised to a temperature of about 400° C. While the flask is still hot a glass tube is introduced into it, and air freed from carbonic acid by caustic potash, and from aqueous vapour by sulphuric acid, is urged through the flask until it is cool. Connected with the ear-tube, and exposed immediately to the intermittent beam, the attention of the ear—if I may use the term—is converged upon the flask. When the experiment is carefully made, dry air proves as incompetent to produce sound as to absorb radiant heat.

In 1868 I had determined the absorptions of a great number of liquids whose vapours I did not examine. My experiments having amply proved the parallelism of liquid and vaporous absorption, I held undoubtedly twelve years ago that the vapour of cyanide of ethyl and of acetic acid would prove powerfully absorbent. This conclusion is now easily tested. A small quantity of either of these substances, placed in a bulb a cubic inch in volume, warmed, and exposed to the intermittent beam, emits a sound of extraordinary power.

I also tried to extract sounds from perfumes, which I had proved in 1861 to be absorbers of radiant heat. I limit myself here to the vapours of pachouli and cassia, the former exercising a measured absorption of 30, and the latter an absorption of 109. Placed in dried flasks, and slightly warmed, sounds were obtained from both these substances, but the sound of cassia was much louder than that of pachouli.

Many years ago I had proved tetrachloride of carbon to be highly diathermanous. Its sounding power is as feeble as its absorbent power.

In its relation to colliery explosions the deportment of marsh-gas was of special interest. Prof. Dewar was good enough to furnish me with a pure sample of this gas. The sounds produced by it, when exposed to the intermittent beam, were very powerful.

Chloride of methyl, a liquid which boils at the ordinary temperature of the air, was poured into a small flask, and permitted to displace the air within it. Exposed to the intermittent beam, its sound was similar in power to that of marsh-gas.

* In such bulbs even bisulphide of carbon vapour may be so nursed as to produce sounds of considerable strength.

The specific gravity of marsh-gas being about half that of air, it might be expected that the flask containing it, when left open and erect, would soon get rid of its contents. This, however, is not the case. After a considerable interval, the film of this gas clinging to the interior surface of the flask was able to produce sounds of great power.

A small quantity of liquid bromine being poured into a well-dried flask, the brown vapour rapidly diffused itself in the air above the liquid. Placed in the intermittent beam a somewhat forcible sound was produced. This might seem to militate against my former experiments, which assigned a very low absorptive power to bromine vapour. But my former experiments on this vapour were conducted with obscure heat, whereas in the present instance I had to deal with the radiation from incandescent lime, whose heat is in part luminous. Now the colour of the bromine vapour proves it to be an energetic absorber of the luminous rays; and to them, when suddenly converted into thermometric heat in the body of the vapour, I thought the sounds might be due.

Between the flask containing the bromine and the rotating disk, I therefore placed an empty glass cell: the sounds continued. I then filled the cell with transparent bisulphide of carbon: the sounds still continued. For the transparent bisulphide I then substituted the same liquid saturated with dissolved iodine. This solution cut off the light, while allowing the rays of heat free transmission: the sounds were immediately still.

Iodine vapourised by heat in a small flask, yielded a forcible sound, which was not sensibly affected by the interposition of transparent bisulphide of carbon. Like those of the bromine the sounds of the iodine vapour were completely quelled by the iodine solution. It might indeed have been foreseen that the rays transmitted by the iodine as a liquid would also be transmitted by its vapour, and thus fail to be converted into sound.*

To complete the argument:—While the flask containing the bromine vapour was sounding in the intermittent beam, a strong solution of alum was interposed between it and the rotating disk. There was no sensible abatement of the sounds with either bromine or iodine vapour.

In these experiments the rays from the lime-light were converged to a point a little beyond the rotating disk. In the next experiment they were rendered parallel by the mirror, and afterwards rendered convergent by a lens of ice. At the focus of the ice-lens the sounds were extracted from both bromine and iodine vapour. Sounds were also produced after the beam had been sent through the alum solution and the ice-lens conjointly.

With a very rude arrangement I have been able to hear the sounds of the more active vapours at a distance of 100 feet from the source of rays.

Several vapours other than those mentioned in this abstract have been examined, and sounds obtained from all of them. The vapours of all compound liquids will, I doubt not, be found sonorous in the intermittent beam. And, as I doubt whether there is an absolutely diathermanous substance in nature, I think it probable that even the vapours of elementary bodies, including the elementary gases, when more strictly examined, will be found capable of producing sounds.

Royal Institution of Great Britain.—At the General Monthly Meeting on Monday, February 7, 1881, William Bowman, LL.D., F.R.S., Vice-President, in the Chair, Miss Adalbertha F. Dubois, Robert Hamilton Few, F.R.G.S., Thomas Gabriel, Mrs. Caroline Gabriel, Mrs. Elizabeth F. Hight, John Henry Knight, Edward W. Lane, M.D., M.A., Walter Farquhar Larkins, Lieut-Col. Llewellyn Wood Longstaff, F.R.G.S., F.Z.S., and Arthur Vacher, were elected Members of the Royal Institution.

* I intentionally use this phraseology.

ON A

NEW APPARATUS FOR SHOWING THE DISSOCIATION OF SALTS OF AMMONIUM.

By Dr. D. TOMMASI.

This apparatus—which I shall call the "Dissocioscope"—is composed (as is shown in the accompanying drawing) of a glass tube 20 or 25 centimetres high and 3 or 4 centimetres in diameter. In the interior of the tube a strip of blue litmus-paper is suspended by a platinum wire, the paper having been previously moistened with a solution of chloride of ammonium.* As the solution of this salt is generally slightly acid, it should be neutralised with a few drops of ammonia; but care must be taken not to add too much, as that might be prejudicial to the reaction subsequently to take place. The solution of chloride of ammonium (pure) in distilled water should be made at the ordinary temperature, and should be a saturated solution. The strip of litmus-paper, after being taken out of the

chloride of ammonium, is slightly dried between two pieces of blotting-paper, and whilst still moist is put in the glass tube.

To perform the experiment, all that is necessary is to plunge the tube into a cylinder of boiling water. The sal-ammoniac immediately dissociates, and the litmus-paper turns red. If the dissocioscope be then plunged into cold water the small quantity of dissociated ammonia recombines with the hydrochloric acid, and the litmus-paper regains its blue colour.

It is evident that this experiment can be repeated as often as desired, and the same results will always be obtained.†

Behaviour of Alcohols with Zinc Powder.—Dr. H. Jahn.—Alcohols distilled with zinc powder heated to between 300° to 350° are resolved into hydrogen and olefine. This decomposition especially takes place with the higher alcohols, beginning with the ethylic. Under the same circumstances methylic alcohol is decomposed into hydrogen and carbonic oxide, and yields a small quantity of marsh-gas.—*Les Mondes.*

* By substituting for the chloride of ammonium the bromide, sulphate, or nitrate, &c., the same apparatus will show the dissociation of these different salts of ammonium.

† The "Dissocioscope" can be procured from Alvergniat, 10, Rue de la Sorbonne, Paris.

ON THE

CHEMISTRY OF SEWAGE PRECIPITATION.*

By Dr. WILLIAM WALLACE.

(Continued from p. 34).

In Birmingham lime has always been the precipitant employed, and a great improvement has been effected in the condition of the river Tame, yet the results are not so satisfactory as they might be if a somewhat different system of working were adopted. The sewage, after receiving its dose of lime, passes through a series of settling tanks; but as the lime precipitate is so light that it will not settle completely unless the water is absolutely at rest, it follows that the effluent is always more or less turbid. I consider it imperative that, where lime is used as the purifying agent, the effluent be further subjected to filtration, either through land, where it can be had of a suitable nature, or through "breeze" or some other suitable material. This fact is now recognised by the Birmingham authorities, who expect in future, by a system of land filtration, to produce a more perfect effluent than they do at the present time. There is a farm of considerable dimensions in connection with the sewage works, the principal use of it being for the disposal of the sludge, the quantity of which is enormous. It is got rid of by covering the ground with a layer of it, and then digging it in. Excellent crops of certain vegetables are produced. Formerly works were in operation to carry out the processes of General Scott for the manufacture of cement from the sludge, and for the treatment of night-soil, but both of these have been abandoned.

In Leeds, where the "A B C" and several other processes have been tried, lime alone is now used, and the results are considered satisfactory so far as the effluent is concerned, although it is not subjected to any description of filtration. Its condition, however, is of the less consequence, since, under any circumstances, it is likely to be purer than the water of the Aire, into which very dirty river it is admitted. Here, as elsewhere, the sludge is the chief difficulty: it is indeed the *bête noir* of sewage purification everywhere, and no town or city should adopt a system of precipitation until it is clearly seen how the sludge is to be disposed of. No matter how it is made or what it contains, it cannot be sold; nor will farmers take it for the lifting in its wet state, except in insignificant quantities. An attempt was made at Leeds, two years ago, to convey away the sludge in barges; but the way in which it was carried out clearly showed that those in charge had no correct conception of the difficulties connected with the process. No sludge is now dried at Leeds, for the obvious reason that the drying costs more than can be obtained for the finished article. On the other hand, the cost of working the precipitation is now much less than it was formerly. Four or five years ago the materials for a modified "A B C" process cost at the rate of 18s. 3d. per hour, while now a quantity of lime (7 tons), costing about £5, suffices for the whole 24 hours. The effluent is satisfactory unless when the sewage is mixed largely with tanners' refuse, when it is of a distinctly brown tint, which lime will not remove. The quantity of sewage averages about 9 million gallons per day, but is sometimes much more.

In Bradford, where lime alone has been used for several years, the average flow of the sewage is 8 million gallons per day. The works are capable of dealing with 10 million gallons; but if by reason of heavy rainfall, this quantity is exceeded, the surplus is passed direct into the Beck, a stream of extraordinary filthiness, which is not likely to be further contaminated by it. The system of precipitation pursued in Bradford differs from any I have seen elsewhere, in this respect, that the sewage does not run continuously into and out of the tanks, but these, which are of comparatively small dimensions, are filled and emptied every hour or so, and the sewage is allowed about three-quarters of an hour of absolute quiescence, during which the precipitate settles down completely. The effluent is passed through or over breeze (riddlings of gas coke), whereby its composition is greatly improved, and it passes into the Beck quite clear, and only faintly coloured by dye-stuffs. I have made analyses of the effluent as first produced, and after passing through the filtering material, and the results show that not only is all supended matter removed, but also that the free lime (so injurious to fish when introduced into a river), is almost all carbonated, and for the most part removed. If we compare with this the composition of the Bradford Beck, taken above the sewage works, it will be seen that it must be considerably improved by the admixture of the purified sewage. Experiments on the large scale at Bradford have shown that, in order to obtain satisfactory results, it is necessary to employ a lime of the best quality. The sludge has hitherto been used exclusively in the making up of waste land in the vicinity of the works, but experiments are now being made with the object of reducing it to a more portable form, so that it migh realise the cost of carriage to some distance. Although the treatment of the sludge afte it is deposited in the precipitating tanks is not all that can be desired, the Bradford works are, on the whole, the best I have seen, and are well worth the study of any Corporation who purpose to adopt precipitation as the means of purifying sewage.

In Bolton, lime is used in conjunction with a certain proportion of carbonaceous matter, and the results are stated to be satisfactory. Owing to the flooded condition of the river, the works were at a stand-still when I visited the town on two occasions. I have, however, ascertained the composition of the dried sludge and the effluent water.

In Windsor the process of Mr. Fritz Hillé is followed. It is a modification of the lime process, "chemical salts" (chiefly chloride of magnesium), and a small quantity of tar being added along with the lime. The "salts" are stated to hasten the deposition of the sludge, while the tar retards the decomposition of the effluent. In the ground connected with the works, which are situated at "The Ham," about three miles from the town, trenches are dug, into which the sludge is run, and as the soil is gravelly the liquid portion readily passes away, leaving the mud in a state in which it can be handled. The composition of the sludge is not essentially different from that obtained with lime alone, and, indeed, contains much less magnesia than that produced at Leeds and Bradford, where, probably, magnesium salts are largely employed in finishing and weighting woollen goods and mixed fabrics. The effluent is further purified by irrigation or land filtration. The ordinary quantity of sewage is 1½ million gallons per day. The tanks and other apparatus are very well arranged. Tottenham and some other places are also worked on Hillé's system.

Coventry has been working for some years under Dr. Anderson's patent, in which sulphate of alumina, with enough lime to throw down the alumina, is employed. At present the works are in the hands of the Rivers Purification Company, to whom the city pays £2,200 per annum for the treatment of the sewage, which amounts to 2 millions gallons per day. The condition of matters here is very much the same now as they were when I visited the works some years since, except in this respect, that all hope of selling the sludge, except for the merest trifle of remuneration, appears to be now at an end; the drying is abandoned, and the sludge is got rid of by spreading on fields, &c. The use of sulphate of alumina is interesting, as it is really the only competitor with lime. The quality of the salt used at Coventry is of the crudest and poorest description; and as the effluent is very good, it shows that a material of the cheapest kind may be successfully employed. No doubt the process, under any circumstances, must involve a greater outlay than if lime were employed, but I consider that this is counterbalanced, to a very considerable extent, by the diminished quantity of sludge to be disposed of. If the phosphoric acid be accepted as the measure of

* A Paper read before the Chemical Section of the Philosophical Society of Glasgow, December 6, 1880.

the manurial strength of the sludge, it will be seen, on comparing the various analyses, that the article produced in works where sulphate of alumina is the precipitant is from twice to three times as strong as that precipitated by lime: in other words, the quantity of sludge is from twice to three times as great in the latter case as in the former, while the effluent from sulphate of alumina is at least as good as that from lime, and does not require, so imperatively, subsequent filtration through gravelly soil or breeze. Then, again, if there is any hope of disposing of the dried or partially dried sludge by sale to farmers, there is a far greater probability of doing so if the calculated value per ton is from 20s. to 27s., as at Coventry, than if it were only from 11s. to 15s., as it is in various places where lime alone is used as the precipitant. In Coventry there is used, along with the sulphate of alumina, a small quantity of copperas (sulphate of iron), and enough milk of lime is afterwards added to make the liquid faintly alkaline. The exact quantities are, for 1,000,000 gallons, 15 cwts. sulphate of alumina, 2¼ cwts. copperas, and 6¼ cwts. lime. The sewage then passes on to the precipitating tanks, of which there are four, each capable of containg 225,000 gallons, and they are wrought on the continuous system, three being always in use, while the fourth is being cleared out. The precipitate goes down rapidly, much more so than when lime alone is used, and the effluent passes off in a constant stream in a fairly purified condition, but usually of a faint rose-colour, arising from the dye-stuffs present in large quantities in the sewage. It is afterwards passed through 9 acres of land laid off as a filtering ground, and separated into portions which are wrought intermittingly. These plots are cropped with mangold, rye-glass, &c., and a portion is planted with osiers, which grow vigorously and yield a good return. The effluent passes into the River Sherbourne at the lowest part of the ground, thoroughly purified from suspended matter and quite inodorous, but still of a faint rose tint.

In Aylesbury the process of the A B C Company has been adopted. The sewage looks very foul, and although on both occasions when I visited the town the works could not deal with the whole of it, that portion which was treated produced an excellent effluent. The substances used for purification are sulphate of alumina and charcoal with or without the addition of clay. No lime is used, as the sewage contains enough free ammonia to decompose the sulphate of ammonia. The sludge is pumped up to a tank on the roof of the buildings, and brought down by a pipe into a filter-press, in which the water is reduced from 90 or 95 per cent to 50 per cent. It is now in the form of cakes, which, when kept in a store or in the open air during dry weather, become dry to the touch, and when ground form "native guano," which is sold for £3 10s. per ton, the calculated value being, however, only 33s., while the selling price, comparing it with farm-yard manure, should be less even than this. The cost of production is given by Mr. Henry Robinson, C.E., in his paper on "Sewage Disposal," 1879, as follows:—Chemicals, labour, &c., £1 12s.; drying, &c., 5s. 8d.; grinding and bagging, 15s. —in all £2 12s. 8d. per ton. This process suits very well for a small population, such as that of Aylesbury (about 6000), situated in the middle of a rich agricultural district, where a small quantity of artificial manure may be disposed of by active agents or by extensive advertising; but it does not appear to be applicable to a large town, where it would be impossible to dispose of more than a trifling quantity of the sludge, and there would be, therefore, nothing to counterbalance the heavy outlay for chemicals. Besides this, it would be impossible to obtain, in sufficient quantity for a large town, the carbonaceous matter, which is an essential ingredient in the process. This is a by-product in the manufacture of prussiate of potash, and the production of it is limited. I do not know any other kind of charcoal, suitable for the purpose, that could be had except at a cost that would preclude its use for sewage purification.

The separation of the sewage proper, and especially that from water-closets, from the surface drainage, has been brought prominently before the citizens of Glasgow, and I consider it necessary to make a few remarks on the subject. It is supposed by some that if the products of the water-closets were kept distinct, amounting, say, to a million gallons a-day, all the other drainage of the city might be passed into the river without danger of causing a nuisance. But I have shown conclusively, by chemical analyses, that the drainage from districts where there are no water-closets is very nearly as foul as that from those provided with those conveniences. The latter use a much larger quantity of water, and this dilution compensates, or nearly so, for the extra amount of impurity. A little consideration will show that, practically, all the water used for domestic purposes is, and must be, more or less foul, and requires purification before being introduced into a river. For example, no liquid enters more readily into putrefaction than the water in which cabbage and other vegetables have been boiled; and the washing of cooking utensils gives rise to very foul water. In fact, kitchen slops of all kinds are very impure, and the soapy water resulting from the washing of clothes is, in many many cases, nearly as bad. In the houses of the industrial classes the kitchen sinks are freely used for purposes for which they were never intended; and, in fact, with the exception of the solid excrement, the sewage contains practically all that is found in that produced in water-closet districts. It comes to this, then, that under the separate system, properly carried out, all that is saved from going into the sewers is the rainfall. In Leicester, where two distinct sets of drains exist, the quantity of sewage from a population of 120.000 is 7 million gallons a day; and the somewhat unsatisfactory condition of the Soar in hot weather is considered to be due, at least in part, to the fact that the street washings pass into the river without purification.

As regards the system of precipitation which it is desirable to adopt in the case of Glasgow, I do not consider it imperative that this point be settled before proceeding with the works. For both systems—that using lime and that in which sulphate of alumina, with or without lime, is employed—the same tanks, apparatus, and filtering beds are required, the only difference being that when the latter process is used, the filtering beds do not require to be quite so extensive as when lime is the precipitant. Glasgow is well situated for both processes: lime of the finest quality can be had at from 12s. to 14s. per ton, and probably, from the dilute nature of the sewage, 15 cwts. per million gallons would suffice; on the other hand, a crude sulphate of alumina, containing also some sulphate of iron, could be made here from the waste shale of our coal fields at a very low price, and the use of this precipitant would keep down the quantity of sludge. The disposal of this substance is one of the most important considerations in the establishment of sewage precipitation works. There is a vast quantity of waste land on both sides of the river which might be reclaimed and rendered valuable by means of the sludge, and I see no reason why it should not be sent off considerable distances by railway, as is done at present with the town refuse, to enhance the value of arrable land. But having several precipitation works, facilities would be given for conveying the sludge in various directions.

Whatever system of precipitation be adopted, the disposal of the sludge is one of the most important elements in the calculation of cost. I have estimated that the sewage of Glasgow—40 to 70 millions of gallons daily—will produce a quantity of sludge which, in the dried state, would amount daily to 135 tons; but as it must be dealt with in its moist condition, it would be a fair estimate to take five times this, or 675 tons, as the quantity to be daily got rid of. If lime alone were used as the precipitant, an average of about 40 tons would be required daily, which, at 12s. per ton, would cost £24 a day, or £8760 per annum. The total cost of working the precipitation process, not including interest on works, would probably amount to somewhere about £25,000 per annum.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 3rd, 1881.

Dr. J. H. Gladstone, F.R.S., Vice-President, in the Chair.

The following certificates were read for the first time:—W. E. Adeney, R. A. Edgell, M. Hiddingh, O. V. Pisani, L. T. O'Shea. It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (February 17). The following papers were read:—

"*On the Estimation of Organic Carbon in Air*," by Drs. Dupré and Hake. In a previous paper (*Journ. Chem. Soc*, March, 1879) the authors demonstrated the possibility of estimating gravimetrically minute quantities of carbon by burning in a current of oxygen, absorbing the carbonic acid in baryta water, converting the carbonate into sulphate, and finally weighing the barium sulphate thus obtained; the substance thus formed weighing 19·4 times as much as the original carbon. The air to be analysed was conducted by glass tubing into the laboratory, and there, after filtration through asbestos, divided by a T-piece and suitable pinchcocks into two equal currents. One of these was sucked through an absorbing apparatus containing baryta water, the other passed first through a porcelain tube containing copper oxide heated to redness and then through an absorption-tube. The result obtained with the first current obviously gives the CO_2 in the air; that with the second, the CO_2 in the air plus the CO_2 due to the combustion of any organic carbon. 10 litres of the ordinary air round the laboratory, after filtration through asbestos, gave 0·0001 to 0·0002 grm. of carbon present as organic carbon. The quantity of air employed in each experiment varied from 4½ to 16 litres. Details of the various experiments are given. The authors have not yet attempted to estimate the suspended organic carbon. The authors criticise the results previously obtained by Boussingault, who found in 10 litres 0·0019 grm. carbon; and by Verser, who obtained in 10 litres 0·00154, about ten times as much as the mean result obtained by the authors (0·000154). They also refer to the results obtained by Pettenkofer in his well-known experiments on the elimination of H and CH_4 by animals. Pettenkofer seems to have assumed that the air in his experiments was free from organic carbon, and thus to have laid his results, on that subject, open to a serious fallacy.

The Chairman remarked on the importance of having a method for estimating satisfactorily the organic carbon in the atmosphere, especially in towns subject to visitations of fog, &c.

In answer to some questions, Dr. Dupré stated that the greatest precautions were taken in making the joints; the glass tubes always overlapped, so as to expose the air as little as possible to the caoutchouc tubing. Ordinary metal gas-tubing was at first employed, but absorbed so much CO_2 that its use had to be abandoned. The excess of carbon found by Boussingault might perhaps be explained by the copper employed by him containing carbon.

Mr. Williams pointed out that ordinary black rubber tube was very pervious to CO_2.

The next paper was "*On the Action of the Copper-Zinc Couple upon Nitrates, and the Estimation of Nitric Acid in Water Analysis*," by M. W. Williams. The estimation is conducted as follows:—Some strips of zinc-foil are placed in a wide-mouth-stoppered bottle, and covered with a 3 per cent copper sulphate solution. When the zinc has acquired a sufficient coating of copper, the solution is poured off, and the copper-zinc couple washed with distilled water, and finally with the water to be analysed. The couple is again drained, and the bottle then filled with the water, stoppered, and placed in a warm (24° C.) situation until the reduction of the nitrates is completed. The clear fluid is then withdrawn and titrated directly by the Nessler method; about 1 sq. decimetre of zinc should be used for every 200 c.c. of water containing 5 parts of NH_3 in 100,000. By saturating the water previously with CO_2, or by adding a little pure sodium chloride to the water, the reaction can be expedited so that it is completed in a few hours. The nitrates are apparently first converted into nitrites and the nitrites into ammonia. As soon as the water contains no nitrites the conversion of the nitrates into ammonia is complete. In order to ascertain when this is the case the author employs meta-phenylene-diamine, which in acid solution gives an intense yellow colour with nitrous acid. To calcareous waters which give a turbidity when the Nessler reagent is added, the author adds a fragment of pure oxalic acid, allows the oxalate to settle, and titrates the clear liquid. The author has investigated the effects of temperature and the addition of various substances on the rapidity of the above reaction. At low temperatures the formation of ammonia is much retarded. The presence of alkalies, sodium hydrate, calcium hydrate, &c., retard, whilst carbonic acid, sodium chloride, &c., accelerate the reaction. The author also gives tables showing the amounts of nitrous acid and ammonia formed at different intervals after the commencement of the experiments. In conclusion the author stated that he had applied the reaction so as to shorten the well-known process of Frankland and Armstrong considerably, and had been able to avoid the addition of sulphurous acid in the process. He hoped to publish these results shortly.

In answer to a question of Mr. Groves, the author stated that bicarbonate of soda hindered the reaction quite as much as the carbonate.

Mr. Maxwell Lyte suggested that as the action of the copper-zinc couple seemed to be electrolytic, the retardation produced by sodium carbonate and the acceleration by sodium chloride were simply due to alterations in the electrical conductivity of the solution.

Prof. Tidy did not quite understand the special advantage of this process over the indigo method. Following out some suggestions given him by Dr. Voelcker, he was now able to estimate the nitrates present in a water with perfect accuracy in ten minutes. In his hands the aluminium method had failed.

Dr. Dupré thought that the great value of Mr. Williams's process was in connection with Frankland and Armstrong's combustion method. If the use of sulphurous acid could be avoided, and the nitrates got rid of by the copper-zinc couple, this method of water analysis would be almost perfect.

Mr. Warington made some remarks as to the precautions which should be taken, in employing the meta-phenylene-diamine test for nitrites. Solutions of different strengths could not be compared together: he had found the method given in Frankland's treatise on "Water Analysis" work well. He did not quite see the advantage of the author's method of estimating nitrates over the indigo method.

Mr. W. Thorp thought that the author's method would be of more importance in connection with the estimation of organic carbon and nitrogen in water than as a method for estimating nitrates. He did not feel inclined to join in Prof. Tidy's condemnation of the aluminium method; he had had much experience with it at one time, and found that it worked satisfactorily. He had some difficulties with it with two classes of waters—rain-water and sea-water. He agreed with Mr. Warington that a direct estimation of the ammonia in water (without distilling) was never satisfactory.

Mr. Lloyd had used the indigo process and the copper-zinc process side by side; in his opinion the first, as modified by Dr. Voelcker, was the most expeditious.

Mr. Williams, in reply, said that he did not distil the water before Nesslerising. To calcareous waters he added a crystal of pure oxalic acid, which precipitated the lime;

he had not found it necessary to distil the water. He thought that when his process was combined with Frankland and Armstrong's chemists would prefer it to the aluminium method. He asked Mr. Thorp how he ascertained when the action of the aluminium had ceased.

Mr. Thorp replied that as all action ceased in five to six hours, and no more ammonia was formed in forty-eight hours than in six, he concluded that all the nitrates were decomposed. He thought that, although the lime might be precipitated, the natural colour of a water would often interfere with the Nesslerising unless the water was distilled.

"*On the Position taken by the Nitro-group on Nitrating the Dibromo-toluenes*," by R. Nevill and A. Winther. The authors conclude that bromine, as well as CH_3, has a tendency to cause the nitro-group to take up a position para to it; or if the para position be occupied, then an ortho position; and further, that the combined influence of CH_3 and one bromine atom can cause the nitro-group to take a position meta to the second bromine atom.

"*On some of the Various Derivatives of Toluene and the Toluidines*," by R. Nevill and A. Winther. The authors have prepared and studied brom-nitro-toluene obtained by the action of ethyl-nitrite on brom-nitro-toluidine, melting-point 74° to 75°. By the action of tin and hydrochloric acid on the first-mentioned substance an oily ortho-brom-para-toluidine was formed, which after solidification melted at 25° to 26°. By the addition of bromine water to a hydrochloric acid solution of this substance, tribromo-para-toluidine was obtained, melting-point 82·5° to 83°. By converting dibromo-nitro-toluidine, melting-point 125° to 130°, into diazo-perbromide, and decomposition with glacial acetic acid, tribromo-nitro-toluene, melting-point 105·8° to 106·8°, was obtained. By reduction with iron and acetic acid tribromo-toluidine, melting-point 118° to 118·6°, was procured. A tetra-bromo-para-toluidine was obtained by the action of bromine water on dibromo-para-toluidine in HCl solution. In conclusion the authors give a table containing the various bromine, nitro, and bromo-nitro-derivatives of toluene and the toluidines investigated by themselves and other chemists.

The Society then adjourned to February 17th, when a ballot for the election of Fellows will take place, and the following papers will be read:—"On a New Apparatus for showing the Dissociation of Ammonium Salts," by D. Tommasi; "On the Estimation of Organic Carbon and Nitrogen in Water Analysis, simultaneously with the Estimation of Nitric Acid," by M. W. Williams.

Erratum.—In last report, page 42, line 37 from top, *after* "molecule" *insert* "of tetrathionate with a molecule."

CORRESPONDENCE.

BENZOL BOILING-POINTS.

To the Editor of the Chemical News.

Sir,—A "Country Tar Distiller" (Chemical News, vol. xliii., p. 46) asks if it is true that the "very unpleasant discrepancies constantly occurring between parties engaged in the sale and purchase of commercial benzol" are due to the fact that the thermometers used in the testing of these benzols differ in the lengths of their indicating columns. I do not think that this is a cause of many discrepancies, there being but little difference in the lengths of the indicating columns of the thermometers used for testing benzols in various parts of the country. Since the minimum and maximum temperatures required in the testing of commercial benzols are 80° C. and 120° C., the length of the indicating column between these two points is the only portion of the thermometer to be considered. That the length of the indicating column can affect the result of the test but little will be well understood if we suppose that we have to deal with a sample, say, of 50 per cent benzol, *i.e.*, a sample which should yield 50 per cent of its bulk on distillation to a temperature of 100° C. 100 c.c. of the benzol are placed in a retort connected with a condenser, the thermometer being fixed in the retort by means of a perforated cork. Heat is applied to the retort; in five or ten minutes ebullition commences at a temperature of about 90° C., and the temperature rises slowly as the distillation proceeds till the thermometer registers 100° C., when the heat is withdrawn, and distillation ceases, the time required being from fifteen to twenty minutes. Hence it will be seen that from one to two minutes is required for every increase of one degree C.; and since the difference between the length of the divisions of any two thermometers representing one degree C. is not likely to be more than $\frac{1}{32}$ of an inch, the thermometer which was influenced by this slight difference during a period of, say, one minute would have a slow action indeed. Thermometers should be so constructed that the length of the indicating column should make no appreciable difference in the quickness of the action. If the ratio between the capacity of the bulb and the bore and length of the tube be the same, then two thermometers differing in the length of their scale would indicate a certain number of degrees in the same time.

The cause of many of the discrepancies in benzol testing is that the test is so simple that its simplicity prevents many persons from seeing the importance of ensuring that the conditions under which the distillation is carried on shall be the same in each case. I suggest the following modification of the existing test:—100 c c. of the sample, which shall fairly represent the bulk, to be taken and placed in an *ordinary* 6-oz. stoppered retort connected with a Liebig's condenser, the condenser tube of which shall be 1 inch internal diameter and 2 ft. 6 in. long, the thermometer to be so fixed in the retort that its point shall be three-eighths of an inch from the lowest portion of the retort. Heat is applied by means of a Bunsen *rose* burner. When ebullition has commenced the heat is so regulated that the benzol shall distil over in separate drops from the end of the condenser tube into the 100 c.c. burette. When the required temperature is reached the heat is withdrawn, and the number of c.c. in the distillate is read off when the benzol has ceased to drop from the condenser tube. The contents of the retort, after cooling, are added to the distillate in the 100 c.c. burette, and the loss, if any, is added to the percentage of the distillate.

It is important that the retort and condenser used in every test should be similar, in consequence of the important part which surface condensation and adhesion play in this test. The heat should be withdrawn from the retort just before the required temperature is reached, as the temperature generally rises a little after the heat is withdrawn. No new cork should be used in important tests, as the absorption of benzol by the cork would lower the result of the test: and no new clean retort should be used, since it is difficult to obtain fair ebullition in a new retort unless a few grains of brick be introduced. Retorts which have been in use some time, and have a slight coating of carbon in the interior, are best adapted for important tests.—I am, &c.,

William W. Staveley.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 2, January 10, 1881.

Conditions Relative to the Theoretic Expression of the Speed of Light.—A. Cornu.—The theoretic expression of the speed of light proposed by M. Gouy does

not rest upon any basis; the cause of the errors which he has committed is fundamentally what the author has pointed out on a former occasion, *i.e.*, the rejection of the consideration of persistent undulations, and finally the omission of the essential characters of a pencil of light.

Crystalline Substances Produced at the Expense of Antique Medals Immersed in the Hot Springs of Baiacci, in Corsica.—M. Daubrée.—Some of the medals were superficially coated with sulphur, and others with a double sulphide of copper and tin, the nearest natural analogue of which is stannine.

The Phylloxera in California.—F. de Savignon.—This pest has long been known by the Californian vine-growers. The comparative slowness of its inroads is ascribed to the non-existence of the insect in its winged state, to the richness of the soil, and to the existence of a parasitic enemy,—an Acarus, the *Tyroglyphus longior*.

Magnitude and Variations of the Images of Purkinje.—M. Croullebois.—A mathematical paper, not capable of useful abstraction.

A Thermo-regulator for High Temperatures.—M. d'Arsonval.—This apparatus cannot be intelligibly described without the accompanying illustrations.

The Detection of Gaseous Compounds, and the Study of some of their Properties by Means of the Spectroscope.—P. Hautefeuille and J. Chappuis.—The gases which issue from the effluve-apparatus of M. Berthelot may be usefully studied by means of the spectroscope. The absorption-bands of pure dry ozone, prepared with oxygen free from nitrogen, disappear slowly at common temperatures, but rapidly at redness, whether observed in close vessels, or as gaseous current. The spectrum finally becomes continuous. The same phenomenon is observed if we destroy by means of heat a mixture of ozone and nitrogen, if the latter has not traversed the effluve apparatus. The spectroscope enables us therefore to follow the isomeric transformation of ozone into oxygen, and to assert that its decomposition does not yield hyponitric acid, the only compound of nitrogen stable at dark redness. It is admitted that by avoiding the use of strong electric tensions the effluve-apparatus enables us to prepare ozone in presence of nitrogen without fearing the formation of hyponitric acid. The spectroscope shows that the electrisation of a very dry mixture containing at least one-seventh nitrogen occasions always at the ordinary temperature the formation of a body not yet described, characterised by a very remarkable absorption-spectrum. The spectrum observed on interposing a column of 2 metres filled with the gaseous mixture obtained under these circumstances, possesses all the large absorption-bands described by one of the authors as characteristic of ozone, and besides fine very black rays in the red, orange, and green. Nitrogen, nitrous, hyponitric, and nitric anhydrides when electrised do not present this spectrum. If the gases which give these two spectra are caused to bubble through water, this water becomes acid, and the gas no longer presents the spectrum of ozone. The introduction into the effluve apparatus of a gaseous mixture imperfectly dried quickly occasions the disappearance of the spectrum superimposed on that of ozone. The spectrum destroyed belongs, therefore, to an anhydrous compound, capable of producing an acid. The same gaseous mixture is rapidly decomposed at a red-heat, yielding hyponitric acid. The spectroscope permits us to follow the phenomenon; the bands of ozone and the new bands are gradually replaced by the bands characteristic of hyponitric acid which remain alone. The decomposition is slow at the common temperature, and if followed with the spectroscope it presents a very important peculiarity. During the period of twenty-four to forty-eight hours the bands of the new body have totally disappeared without a trace of hyponitric acid, which then appears gradually, and the decomposition is complete at the end of some days. From these facts it may be inferred that the body formed is first decomposed into oxygen and nitric anhydride, which in turn is resolved into hyponitric acid and oxygen. The body capable of giving the new spectrum is therefore susceptible of yielding hyponitric acid on decomposition. In connection with these results M. Berthelot remarks that hyponitric acid if submitted to the action of the effluve in presence of oxygen becomes colourless. The authors, repeating this experiment, find that the mixture in question not merely becomes colourless, but presents the bands of the new compounds without those of hyponitric acid. These experiments are easily interpreted if we admit the existence of pernitric acid.

The Bromides and Iodides of Phosphorus.—M. J. Ogier.—A thermo-chemical study.

Bulletin de la Société Chimique de Paris.
No. 1, July 20, 1880.

Action of Certain Chlorides on Aniline Colours.—Girard and J. A. Pabst.—The authors introduced into tubes the chlorides of silicon, $SiCl_4$, of carbon, CCl_4, and of tin, $SnCl_4$, with four times their respective volumes of chemically pure aniline, which with arsenic acid yielded not more than 1-5000th of its weight of mauvaniline without a trace of red or yellow. The tubes were sealed and heated for twelve hours to 225° to 230°. No pressure was observed when they were opened. The carbon perchloride had produced triphenyl-guanidine, rosaniline, and a brown matter, offering all the reactions of Bismarck brown, which is well known to be produced by the action of aniline hydrochlorate upon rosaniline. Tin perchloride yielded violaniline and mauvaniline in small quantity, a large proportion of rosaniline or para-rosaniline; also Bismarck brown, and a trace of a green matter. Silicon chloride yielded violaniline, and especially triphenylene diamine blue, as well as a trace of mauvaniline. Antimony perchloride, heated with aniline to 125°, reacted very violently, forming violaniline, a small quantity of triphenylene diamine blue, and a certain quantity of a blue matter, analogous to that produced by the action of hydrochloric acid upon the azoic compounds. Thus, notwithstanding the parallelism of their properties and constitutions, carbon chloride yields rosaniline; silicon chloride, violaniline; and tin chloride, both these colouring-matters.

Russian Chemical Society.—Session, September 6/18, 1879.—M. Latchinoff described a remarkable oxidation-product of cholalic acid.

MM. Beilstein and Jawein gave a new method for the direct separation of manganese and iron, based upon the fact that all the salts of manganese are precipitated as peroxide when boiled with concentrated acid and potassium chlorate.

M. Sorokine finds that the oxidation of diallyl with an aqueous solution of chromic acid yields, not merely a mixture of carbonic and acetic acids, but also a small quantity of fixed acids, including the succinic.

M. J. Ossipoff gives a preliminary notice on the ethers of fumaric and maleic acids. He also announces that fumaric acid is not oxidised by nitric acid of sp. gr. 1·2 to 1·4.

M. Menchoutkine spoke on the influence of the isomerism of the saturated mono-basic acids upon the formation of compound ethers.

M. Mendelejeff described the sulphur deposits of Sicily and the mode of their formation.

M. Wischnegradsky gave a preliminary communication on a new base derived from quinine.

The seventh part of vol. xi. of the *Journal of the Russian Chemical Society* contains further a long memoir by M. Lubavine on the nucleine of milk. He concludes that nucleine is a mixture of at least two substances, which differ respectively in their proportion of phosphorus.

Moniteur Scientifique, Quesneville.
August, 1880.

Industrial Society of Mulhouse.—At a special meeting of the Society, June 14, a letter was read from M. Caro contending that Messrs. Lloyd and Dale, and not Mr. Thomas Brooks, invented the process for fixing aniline colours by the joint action of tannin and tartar-emetic. A silver metal was offered for a decided yellow colour equal in permanence to alizarin, and fixed in the same manner. A note from M. Brandt was read on the preparation of stannic sulphocyanide by the double decomposition of calcium sulphocyanide and stannic oxalate. It is likely to find extensive applications in calico-printing. M. Dollfus read some extracts from a report on cadmium yellow. M. Jacquet has observed that a few grms. of a salt of cadmium added to a chromate of lead colour, considerably retard the sulphuration of the latter during steaming. MM. Noelting and De Salis communicated investigations on the nitrised cresylols. On treating the diazoic derivative of ortho-toluidine with nitric acid they obtained a binitrc-cresylol fusible at 86°, and yielding crystalline yellow salts. It appears to be identical with a compound discovered by M. Piccard in a commercial product known as saffron substitute.

New Synthesis of Desoxy-benzoin and Crysen. MM. Graebe and Bungener.—The authors have obtained desoxy-benzoin by causing the chloride of phenyl-acetic acid to react upon benzol in presence of aluminium chloride. By the same reaction, naphthalin being substituted for benzol, they produce benzyl-naphthyl-keton. They then reduce with hydriodic acid and phosphorus at 150° to 160°, and pass the vapours of the carbide thus obtained through a red-hot tube, when 4 atoms H are removed and chrysene remains.

Chlorinated Derivatives of Carbazol.—W. Knecht. —On treating carbazol suspended in acetic acid with chlorine, the liquid turns blue, yellowish, greenish, and, lastly, red. If the reaction is then interrupted the product is trichloro-carbazol in white needles, melting at 185°. If the process is continued for ten to twelve hours, hexachloro-carbazol is produced, fusible at 225°.

A Novel Ferric Hydrate.—C. Graebe.—The author has received from the Baden Aniline and Soda Works a reddish crystalline substance deposited in cast-iron vessels in which potash had been melted. It has the same composition as hematite and gœthite, but its specific gravity is only 2·93.

Manufacture of Soda from Sulphate.—J. Putzkow. —Salt-cake is produced in quantity in California in the manufacture of nitric acid. As coal and lime-stone are dear in California, Le Blanc's process is not economical. The author therefore proposes to mix a solution of salt-cake with calcium sulphite and pass in sulphurous acid. Soluble calcium bisulphite is formed, and by decomposition calcium sulphate and sodium bisulphite. The two salts are separated by filtration, and the sodium bisulphite is treated with milk of lime. The result is a solution of caustic soda, retaining a certain quantity of sodium sulphite and sulphate, which is evaporated down in the usual manner, and calcium sulphite, which is used again in the process.—*Dingler's Pol. Journ.*

Observations on the "Mother" of Vinegar.—J. B. Schnœtzler.—The so-called "mother of vinegar" is an accumulation of the fungus *Mycoderma aceti*, which Pasteur has ascertained to be the agent in the transformation of wine into vinegar. The so-called *fleur de vin (Saccharomyces mycoderma)* is a perfectly distinct organism and does not induce acetification, but the alcoholic fermentation.

The Banishment of Bees.—At the petition of the Parisian refiners of beet-root sugar, the Prefect of the Seine has proscribed bees in the neighbourhood of the city. A single refiner in the 13th arrondissement estimates his losses at 25,000 francs.

Perforation of Zinc Reservoirs.—X Rocques.—The causes which lead to calcareous deposits and the corrosion of leaden pipes occasion likewise the attack of zinc reservoirs, *i.e.*, the chemical action of the salts dissolved in the water, and the electric action of lead and copper or lead and iron.

September, 1880.

Preparation of the Salts of Uranium and Vanadium at Joachimsthal, Bohemia. — C. Lallemand. — The uranium ore is pitch-blende of the sp. gr. 7. It contains on an average 40 to 55 per cent of urano-uranic oxide (U_3O_4), besides vanadium, arsenic, sulphur, molybdenum, tungsten, cobalt, nickel, copper, bismuth, lead, silver, iron, manganese, lime, magnesia, alumina, and silica. The analysis of the sample is thus performed; a portion of 3 grms. is heated on the sand-bath with moderately concentrated nitric acid. At the end of two hours the reaction is complete; the solution is decanted, and the residue filtered and washed with hot water till the washings no longer give the characteristic red colour with potassium ferrocyanide. The collected liquid is then mixed with sodium carbonate in excess, and boiled to expel free carbonic acid. The totality of the vanadium, iron, lime, lead, copper, &c., is thus precipitated, whilst uranium remains in solution. The sediment is allowed to settle for some hours, after which it is decanted, washed with hot water by decantation, filtered, and washed upon the filter with hot water until the washings, after slight acidulation with hydrochloric acid, no longer give a red colouration with potassium ferrocyanide. The excess of sodium carbonate is then decomposed by the addition of hydrochloric acid, the free carbonic acid being expelled by boiling, and caustic soda is then added, which throws down all the uranium as sodium uranate with excess of alkali. The mixture is decanted, filtered, and washed very slightly on account of the ready solubility of sodium uranate in pure water; it is dried. the filter detached and burnt, its ash added to the precipitate, and the whole ignited at dull redness in a platinum crucible. When cold it is washed in cold water to remove excess of soda, filtered, dried, ignited, and weighed. We have thus a certain weight *p* of sodium uranate, $NaO,2N_2O_3$. The corresponding weight of U_3O_4 is found by calculation. The practical treatment of the ore comprises five operations:—Roasting the ore with sodium nitrate and carbonate, lixiviation of the roasted mass, treatment of the residues with sulphuric acid, precipitation of the foreign metals with sodium carbonate, and purification of the liquid and precipitation of the uranium. This precipitation is effected differently according as it is desired to obtain the product in a light yellow or the orange state. For the former the liquid is precipitated with caustic soda, until a portion of the liquid on acidulation no longer gives the red reaction with potassium ferrocyanide. To obtain the orange-coloured variety the carbonate of soda is very gradually neutralised with sulphuric acid, avoiding excess. The precipitation is complete. Six different preparations of uranium are produced —uranate of soda, of a light yellow, an orange, and a bright orange; uranate of potash, of a bright orange; uranate of ammonia, of a light yellow; and black uranium oxide. The vanadium present in the Joachimsthal ore does not exceed 0·1 per cent, and the methods tried for its extraction do not appear to have been commercially successful.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 4, October 7, 1880.

On Sulpho-hydantoine.—R. Andreasch.—This compound, formerly prepared only by the contact of sulphourea with mono-chloro-acetic acid, may likewise be obtained by heating a mixture of cyanamide and thioglycolic acid.

On Matter Radiating from Electrodes.—Dr. J. Puluz.

MISCELLANEOUS.

The Brush Electric Light.—We learn that the electric lights, mentioned in our issue of January 21 (page 37) as in successful operation at the River Side Spinning Mills at Providence, New Jersey, are on the Brush System, not on that of Edison.

NOTES AND QUERIES.

Sulphur for Manufacturing Purposes.—Will any of your readers oblige by information concerning a new kind of sulphur coming into use in the manufacture of sulphuric acid, and where it may had?—A SUBSCRIBER.

MEETINGS FOR THE WEEK.

MONDAY, 14th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Geographical, 8.30.
—— Royal Institution, 3. "The Troubadours," Mr. F. Hueffer.
—— Society of Arts, 8. "Watchmaking," by Edward Rigg, M.A.
TUESDAY, 15th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
WEDNESDAY, 16th.—Society of Arts, 8. "The Participation of Labour in the Profits of Enterprise," Sedley Taylor, M.A.
—— Meteorological, 7.
THURSDAY, 17th.—London Institution, 7.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
—— Chemical, 8. Ballot for Election of Fellows. "On a New Apparatus for Showing the Dissociation of Ammonium Salts," D. Tommasi. "On the Estimation of Organic Carbon and Nitrogen in Water Analyses Simultaneously with the Estimation of Nitric Acid," Mr. W. Williams.
—— Royal Institution, 3. "Drawing Room Music," Prof. Pauer.
FRIDAY, 18th.—Royal Institution, 8. "Fruits and Seeds," Sir John Lubbock, 9.
—— Geological (Anniversary), 8.
SATURDAY, 19th.—Royal Institution, 3. "Ancient Egypt," Mr. R. S. Poole.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1108.

ON THE

INFLUENCE OF THE MOLECULAR GROUPING IN ORGANIC BODIES ON THEIR ABSORPTION IN THE INFRA-RED REGION OF THE SPECTRUM.*

By Captain W. DE W. ABNEY, R.E., F.R.S., and Lieutenant-Colonel FESTING, R.E.

The authors describe the apparatus used by them in their research and their plan of mapping the absorption spectra, the results being given in wave lengths. The source of light for obtaining a continuous spectrum was the incandescent positive pole of an electric light, the electricity being generated by a Gramme machine. The light was passed through tubes containing the fluid, and the absorption spectra photographed in the infra-red region.

The absorptions they met with they classed as follows:—

1st. General absorption at the least refrangible end of the spectrum.

Lines .. { Fuzzy. / Sharp.

Bands .. { Both edges sharply defined. / One edge sharply defined. / Both edges less sharply defined.

The authors next discuss the causes of the different absorptions met with in various fluids. From experiment they show that a large number of lines which are formed in hydrocarbons containing no oxygen are common to substances containing hydrogen and no carbon, and that in carbon tetrachloride and carbon disulphide, no lines or bands are to be met with. By this eliminating process they deduce the fact that the presence of lines is due to the hydrogen in the bodies. They show that the termination of the bands in liquids containing carbon, hydrogen, and oxygen corresponds with the position of these hydrogen lines. It therefore appears to them that the bands are in reality a blocking out of radiation between two hydrogen lines. By increasing the thickness of the fluid in front of the slit, the bands may be widened to another hydrogen line, each hydrogen line acting as a stepping-stone, or they may remain constant if both edges are defined, or they may be obliterated by general absorption. On the other hand, lines may be spread out to bands as the thickness of liquid is increased. When the thickness of the fluid is diminished the lines may disappear, and the bands become lines, or the bands may remain constant though fainter.

The authors then point out that each radical has its own definite absorption in the infra-red, and that such a radical can be detected in a more complex body. It also seems possible that the hydrogen which is replaced may be distinguished by a comparison with other spectra. They next point out coincidences between some of the lines obtained, the absorption spectra of the hydrocarbons, and the spectra of bodies containing no carbon with solar lines, from which they reason that at present it is not safe to infer that such lines in the solar spectrum are not necessarily due to water. Whether the lines mapped are due to hydrogen or not, it is perfectly evident that every organic body has a definite absorption spectrum which connects it with some series. The paper closes with an appendix giving tables of the bands and lines found in the following substances, of which also there are maps —

Methyl iodide.	Glycerine.
Ethyl iodide.	Benzene.
Propyl iodide.	Phenyl bromide.
Amyl iodide.	Benzyl chloride.
Phenyl iodide.	Nitrobenzol.
Ethyl bromide.	Aniline.
Amyl bromide.	Dimethyl aniline.
Methyl alcohol.	Turpentine.
Ethyl alcohol.	Olive oil.
Propyl alcohol.	Aceto-acetic ether.
Isopropyl alcohol.	Diethyl aceto-acetic ether.
Isobutyl alcohol.	Benzylethyl ether.
Pseudobutyl alcohol.	Methyl salicylate.
Amyl alcohol.	Cinnamic alcohol.
Diethyl ether.	Phenylpropyl alcohol.
Amyl ether.	Dibenzyl acetic ether.
Ethyl nitrate	Allyl alcohol.
Ethyl oxalate.	Allyl sulphide.
Ethyl sulphide.	Anethol.
Aldehyd.	Citraconic anhydride.
Paraldehyd.	Water.
Formic acid.	Nitric acid.
Acetic acid.	Hydrochloric acid.
Propionic acid.	Sulphuric acid.
Isobutyric acid.	Ammonia.
Valerianic acid.	Chloroform.

* Abstract of a Paper read before the Royal Society, February 10, 1881.

LABORATORY OBSERVATIONS.

On the Detection of Small Quantities of Platinum.

By FREDERICK FIELD, F.R.S.

It is well known that when potassic iodide is added in slight excess to a solution of platinic chloride, the platinic iodide is dissolved, and, should the solution be concentrated, a dark red liquid, almost approaching to black, is produced. It is not generally known, however, as far as I am aware, that very minute traces of platinum can be detected in this way, and in many cases where that metal is in combination with a very large excess of other metals it may be distinctly recognised. In order to show the delicacy of the test, 0·1 grm. of a platinum was converted into the chloride, evaporated carefully to dryness, care being taken that every trace of nitric acid was expelled. This was dissolved in a 1000 c.c. of water, each c.c. therefore containing 1-10,000th part of platinum, to which a drop of potassic iodide imparted immediately a dark rich rose-colour, strikingly resembling a concentrated solution of cobalt nitrate. 10 c.c. of this was made up to a litre (1000 c.c.), so that every c.c. contained 0·000001, or one-millionth of platinum. A portion of this liquid was transferred to a capacious beaker, and a solution of iodide added. It remained colourless for a few minutes, and then assumed a beautiful rose-coloured tint, very like that of a manganese salt. At the end of some hours the colour was very much intensified. At this state of dilution of platinic salts there is no apparent change effected by the introduction of sulphuric acid. The litre was made up to two litres, and the colour after some hours was distinctly observable. Thus it seems that *one* part of platinum in two *millions* of liquid can be detected by this test. It was observed that a drop or two of acid added to the solution accelerated the development of the colour. Upon further experiments it was proved that sulphydric acid, sodic sulphite and hyposulphite, sulphurous acid, mercuric chloride, and certain other reagents immediately destroyed the colour. Also, when the pink solution is heated the tint disappears. The sulphites and other deoxidisers doubtless convert the platinic salt into platinous, and the change of colour is thus explained. It is more difficult to understand the action of mercuric chloride. Heat, it may be surmised, produces a *disassociation*, the

platinic iodide being thrown out of solution when so highly diluted, and the precipitate too minute to be discernible.* Further experiments were made upon the detection of platinum when in combination with other metals, and it may be stated that solutions were so prepared that the platinum was in the proportion to the others as one to a thousand, and in many cases much less.

Zinc and Platinum.—About 1 grm. zinc chloride was dissolved in 100 c.c. water, and a milligrm. of platinic chloride added. The rose colour was developed after a few minutes, on the addition of potassic iodide.

Iron and Platinum.—About the same quantity of both metals as above (the iron as a ferrous salt), dissolved in a similar amount of water, gave equally satisfactory results. When the iron exists in a ferric compound, the results are not satisfactory, as the platinic chloride on boiling with sulphurous acid (which is necessary to convert the *ferric* into the ferrous salt) is also reduced, and no colour is afforded on addition of the test.

Cadmium and Platinum.—Results perfectly satisfactory.

Manganese and Platinum.—Equally so.

Cobalt and Platinum.—Cobaltic salts, even when highly dilute, possessing a pink colour, the reaction of potassic iodide is not so conspicuous. If, however, the cobalt solution contains platinum, the introduction of the alkaline iodide imparts a far deeper tint. This can be satisfactorily shown by having two beakers of equal diameters, one with a solution of pure cobalt, the other with a solution of the same strength, to which a little platinum is added. Upon the addition of the iodide, the difference of colour between the two is sufficiently evident.

Nickel and Platinum.—The detection of platinum in nickel is not satisfactory, unless the solution be so dilute as to render the green colour of the nickel salt imperceptible. It is well known that dilute solutions of cupric chloride and potassium permanganate, or cobalt and nickel salts, when mixed in proper proportions, become almost colourless. The action of manganic oxide on common green glass in a state of fusion, and commonly known as glass-makers' soap, is doubtless owing, not to any definite action on the vitreous mass, but simply to the *neutralisation*, so to speak, of the green, by the amethyst, produced by the manganese. Hence the rose colour of the platinum is disguised by the green of the nickel.

Solutions were made of silver, lead, iron (ferrous), mercury, cadmium, cobalt (in small quantity), and zinc. A minute trace of platinum was added, and a drop or so of the iodide. The pink colour was at once apparent. Nickel was added to another portion of the liquid, but the iodide in this instance produced no change, except, perhaps, a dull grey colour.

Lead and Platinum.—When potassic iodide is added to a solution of these metals, the production of lead iodide somewhat interferes with the result. It is always better to add previously, dilute sulphuric acid or a sulphate of one of the alkali metals, and allow a complete precipitation of the lead sulphate. Very minute traces of platinum can now be detected.

Copper and Platinum.—As potassic iodide precipitates cuprous iodide from cupric solutions, the test in this instance cannot be directly applied. A solution containing the two metals, and free from nitric acid, may be precipitated by zinc, and the metallic deposit digested in dilute nitric acid, which will dissolve the copper, leaving a slack powder of platinum. This, dissolved, with the necessary precautions, gives the characteristic colour on the addition of the iodide.

Mercury and Platinum.—On the cautious addition of the iodide, the red precipitate of the mercuric iodide is redissolved in the excess of the mercuric chloride (if that salt has been used), and the solution remains colourless, for, as it has been previously stated, mercuric chloride destroys the rose colour of the platinum compound. On further addition and slight agitation, the whole of the mercuric iodide is precipitated and the supernatant liquid is pink. To avoid filtration, more iodide may be added until the mercuric iodide is entirely dissolved.

Silver and Platinum.—There is no difficulty in the dilution of minute traces of platinum in silver. The latter metal is first removed by a soluble chloride, and the platinum detected in the usual manner. A still simpler method is to add excess of potassic iodide to the solution. The silver is entirely precipitated, and a supernatant rose-coloured liquid is discernible.

Bismuth and Platinum.—The detection of platinum in bismuth by this process is not satisfactory.

Gold and Platinum.—Auric chloride has a very strong colouring power. A drop of a moderately strong solution of this salt imparts a bright yellow to a thousand times its volume of water. The colour is exceedingly intensified by auric iodide, or rather a solution of auric iodide in potassic iodide. When this last-named salt is added to a solution of gold which is so weak as to impart no perceptible colour, a yellow tint appears. As this yellow would very much disguise the rose of the platinic compound, it is necessary to remove the gold before the application of the test. This is easily effected by the addition of an excess of oxalic acid, the gold is precipitated, and the colour on the addition of potassic iodide is developed. One part of platinum in a thousand parts of gold is readily detected by this means.

Palladium and Platinum.—It is difficult to detect platinum in the presence of palladium by potassic iodide, for this salt appears to dissolve palladious iodide, although it would seem the latter is always in very minute mechanical division, for the brownish red liquid, apparently perfectly clear and bright, becomes colourless after a few days, and a mirror of the iodide is seen on the sides of the vessel. Long practice, perhaps, might enable one to distinguish the difference between the two iodides, but the test cannot be considered as reliable in this instance.

Rhodium and Platinum.—As the salts of rhodium have as nearly as possible the same colour as the solutions of platinic or potassic iodide, the test is also in this case inadmissible.

My observations have extended to the action of certain organic substances upon the "rose colour," so often mentioned in the above paper, and I believe they are not altogether without interest to the chemist.

* Experiments have been made recently upon these rose-coloured solutions, which will shortly be communicated.

HOW IS PETROLEUM TO BE EXAMINED?

By F. SKALWEIT.

The various results obtained these last two years by several chemists who have examined the same petroleum with a view to ascertain how far it is fit or unfit for a given purpose, induced me to look for other means than those used up to the present day, in order to discover the degree of its inflammability and its defective qualities.

The first thing to be done was to exactly determine its specific gravity and its boiling-point. Thus it was found that the various kinds of petroleum which, at a lower point of temperature, develop inflammable gases, have a specific gravity under 0·800 and even 0·789, whereas good sorts are considerably heavier, and rise to 0·824. The boiling-points, also, are considerably lower; and it is clear that the inflammability of such petroleum depends, to some extent, on its boiling-point, as follows:—

			Igniting-point.
First change from carbd. hydrogen at		100° C.	22°
,,	,,	,, 108	24
,,	,,	,, 121	26
,,	,,	,, 126	25·5
,,	,,	,, 130	30
,,	,,	,, 133	31
,,	,,	,, 138	35
,,	,,	,, 141	37
,,	,,	,, 180	65

The latter petroleum is sold here in Hanover under the name of "Safety Oil" (*Sicherheits öl*), and is obtained from the factory of Dr. W. H. Lepenau, of Salzbergen. According to these experiments, petroleum, which in the usual process of distillation develops inflammable hydrogen gases at 140° or lower, will probably not answer the requirements of the English law, which prescribes that petroleum shall emit inflammable gases at 38° C. only. This has, up to now, been the case with the various kinds of petroleum which have come within my observation. Many more experiments will be necessary to be able to legally determine the lowest permissible boiling-point instead of the igniting-point. Should this become feasible, the matter would be greatly simplified, to the general satisfaction of most chemists. Whatever may be said to the contrary, all the apparatus which have been used up to the present day to fix the igniting temperature require that the experimentalist shall work his apparatus for some days at least before he can obtain concordant results; they pre-suppose constant practice and proper management.

I hoped, however, to find a simpler way than that of determining the specific gravity and boiling-point in fixing the angle of refraction; and as I have, for several years already, consulted Abbé's refractometer in examining crude glycerin and oil, I made use of the same for analysing petroleum. The experiments were made at a temperature of 17° to 18° C. The index of the alidade was so adjusted that water of 17° to 18° C. showed an average of $n = 1{\cdot}3330$ from both results.

Specific Gravity.		Distillation.	Index of Refraction.	Igniting-point.
0·7942	to	130° — 1 %	1·4431	29° C.
0·8242		180 — 0 %	1·5549	65
0·7920		110 — 2 %	1·4265	24
0·7930		not quoted	1·4289	28
0·7937		132° — 1 %	1·4320	32
0·8012		141 — 1 %	1·4489	38

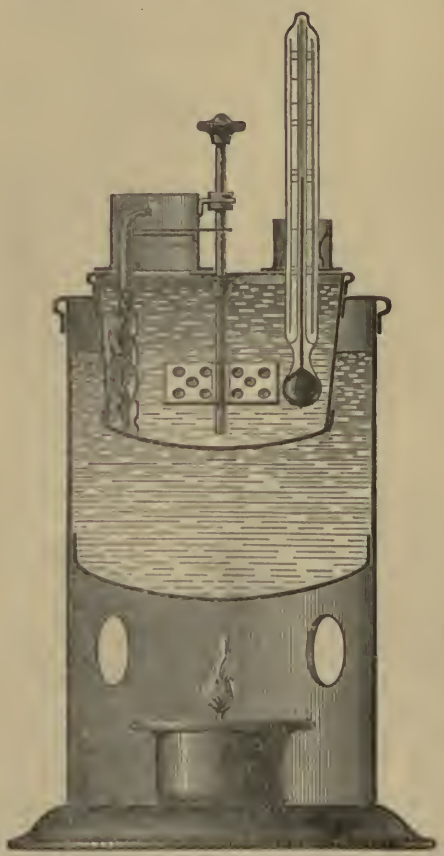
These few data, which might be considerably increased, show at a glance a great difference in the index of refraction with various kinds of petroleum; but its irregularity in rising and falling, compared with the igniting-point, is also exhibited. The igniting-point concurs most with the specific gravity and the boiling-point. This becomes particularly evident when the distillates of petroleum, boiling at a low point, are separately examined.

			Index of Refraction.
For the distillation between	100°	110° C.	1·3991
,,	,, 110	120	1·4033
,,	,, 120	130	1·4087
,,	,, 130	140	1·4101
,,	,, 140	150	1·4125
,,	,, 150	160	1·4151
,,	,, 160	170	1·4179
,,	,, 170	180	1·4205
,,	,, 180	190	1·4239
,,	,, 190	200	1·4279
,,	,, 200	210	1·4308
,,	,, 210	220	1·4332
,,	,, 220	230	1·4359
,,	,, 230	250	1·4395
,,	,, 250	280	1·4458

According to these examinations, petroleum, for which a specific gravity of above 0·800 and an igniting-point of 38° C. is sufficient, has an angle of refraction of 1·4489. With some practice the last examination is very simple, and requires a few minute's time only. Most chemists are likely to prefer it to any other process, for, as it is, it gives a clue to find out its usefulness or its defectiveness. If, however, in examining petroleum its physical properties are entirely left aside, and importance is attached solely to its quality of igniting and burning, the apparatus must be self-acting and sufficiently safe.

From several hundreds of experiments I may perhaps infer that the many apparatus which have been in use up to the present day do not answer the purpose. I would not, therefore, venture to increase their number by one were I not induced to do so by several chemists of the province of Hanover, who for some time already have, to their greatest satisfaction, worked with my petroleum tester, and were I not convinced that this little apparatus—which, thermometer included, costs here in Hanover only 5 marks (5 shillings)—fully answers its purpose. The same advantage cannot be expected even from the best and most expensive apparatus known.

The accompanying diagram, half natural size, plainly exhibits the simplicity of its construction.



A small petroleum cistern containing 120 c.c. has inside a small perforated petroleum chamber with a soldered edge, by which it hangs on a water vessel of 300 c.c. The one fixes the other. The lid of the petroleum cistern has a rectangular edge, and is closed by an iron stang fixing the lid with the cistern. In the lid four parts are to be noticed:—(1) A cap of 2 c.m. high; (2) a mixing rod with knob; (3) a small brass plate: (4) an aperture for the thermometer. The cap has, 1 c.m. above the lid, a brass disconnecter: in its centre is a little hole, which is closed by means of a thin brass plate moving on the disconnecter. The object of the brass disconnecter is to fix a small tube, in which is placed a cotton wick. By adding that under the water vessel there is a good spirit-lamp, I complete the description of the apparatus.

The petroleum to be examined fills the vase up to the edge of the interior chamber which is to receive the cotton wick. The lid being put on, the spirit-lamp is lit along with the little lamp in the cap. The knob is now to be

turned from time to time, and the thin brass plate to be drawn out. Nothing else is required. In about ten minutes the examiner will have ascertained the inflammability (flashing-point) of the petroleum. For the very moment inflammable gases begin to issue through the aperture under the little flame they ignite, and the flame is extinguished with little loss. The spirit-lamp is then to be put out, the lid to be removed, and the thermometer to be placed in the petroleum chamber now prepared for it. Now and then a burning match is quickly brought in contact with the petroleum, and, after blowing it out, the igniting temperature is read, when the whole surface will be in a blaze and continue burning.

The experiments made with this apparatus by several chemists have produced the most favourable—and in each case invariable—results.

DECOMPOSITION OF SLAGS AND SILICATES

By MALVERN W. ILES.

The well-known method of fusing finely-divided silicates with sodium or potassium carbonate in a platinum crucible over a blast-lamp has generally no special objections. There are, however, laboratories connected with technical works so located that gas cannot be obtained, hence blast-lamp fusions cannot be resorted to. Slags containing lead, as in the treatment of lead ores by the blast-furnace, should not be fused in a platinum crucible, even when the slag shows as low as 1 per cent of lead by fire assay, and even when a large excess of flux is used.

The method I have to suggest originated from a long-felt desire for a rapid and accurate decomposition of lead slags, in the performance of a complete analysis.

The mode of procedure may be stated as follows :—

From 45 to 50 grms. pure potassium hydroxide are fused in a large silver crucible until the mass has assumed a quiet fusion. (Capacity of crucible 70 c.c. water.) Upon the surface of the cooled mass, 1 grm. finely-powdered silicate is introduced, and the heat is gently applied, increasing the heat toward the end of the fusion, which rarely exceeds thirty minutes.

Manganate, silicate, and aluminate of potassium will be found, and the iron will remain as a sesquioxide; in short, much the same chemical reactions will ensue as when fusion is made in a platinum crucible with carbonates of the alkalies.

There is, however, a marked difference in the time required for the performance of the process, and the rapidity of the disintegration of the fused mass when treated with water. The lead will not attack the silver crucible in the slightest degree, which is not the case when platinum vessels are used, as has already been indicated.

After the fusion has been completed, the crucible is allowed to cool and introduced into a vessel containing just sufficent water to cover the crucible, and the mass allowed to dissolve. The silicic acid is then separated as usual. It must be remembered, however, that fused potassium or sodium hydroxides will slightly attack silver vessels, and one must take the precaution to wash the silicic acid with some one of the well-known solvents for argentic chloride, as strong ammonia or sodium hyposulphite. This, however, is rapidly and completely performed.

The above mode of procedure has the following advantages :—

1. Rapidity of execution.
2. Complete decomposition.
3. Obviates the use of gas.
4. Replaces the expensive platinum crucibles by less expensive ones.
5. Less liability to loss in the performance of the operation; since by dehydrating the potassium hydroxide before beginning the operation, it then continues quietly to its completion.

It need scarcely be mentioned that this method suggests a mode for the separation of aluminium from iron; also a volumetric method for the determination of manganese, since potassium manganate is quite stable in an excess of caustic alkalies.—*Engineering and Mining Journal.*

Chemical Laboratory, Grant Smelting Co.,
Leadville, Colo.

ON THE

LOSS OF NITROUS COMPOUNDS IN THE MANUFACTURE OF SULPHURIC ACID, AND ON A METHOD FOR THEIR ABATEMENT.

By MM. LASNE and BENKER.

In the ordinary working of vitriol-chambers provided with the Gay-Lussac tower there is lost a certain quantity of nitrous compounds, which involves a corresponding consumption of nitrate of soda or nitric acid. Having studied the cause of these losses, we have succeeded in reducing them to the third part of what they reach in the best conducted establishments. The only really important loss is that produced by the proportion of hyponitric acid in the gases which have traversed the Gay-Lussac tower and escape into the atmosphere. The gases which issue from the lead-chambers ought to contain at least 5 per cent of oxygen in excess, which is necessary in order that the oxidation of the sulphurous acid may be complete. We are led to admit that in presence of this quantity of free oxygen the nitrous compounds are in the state of hyponitric acid. On the other hand, it is understood that the sulphuric acid, charged with nitrogen products on its passage through the towers, contains exclusively nitrous acid. We have verified this fact by repeated experiments under the most varied circumstances which the progress of the works permitted. Here is therefore an apparent contradiction which has struck us, and for which we have sought an explanation. The hyponitric acid dissolves in sulphuric acid at sp. gr. 1·689, and can combine with it under certain circumstances. But these compounds have little stability, and their tension of dissociation is very great, even at common temperatures, so that the passage of a current of dry air or of carbonic acid liberates the hyponitric acid entirely, and unchanged. A slight rise of temperature accelerates this liberation. In the gaseous mixture which enters the towers the hyponitric acid occupies merely 3-1000th parts of the total volume. Its tension, therefore, is very slight, and it may be conceived that the sulphuric acid cannot retain it in important quantities. Thus we do not find it in sensible quantities in the air which flows from the apparatus.

Nitrous acid behaves very differently: it forms with sulphuric acid a definite and stable compound, which is not destroyed by the action of a moderate heat, nor even by a current of sulphurous acid. It is only by dilution with water that we can decompose this nitroso-sulphuric compound, known as "chamber crystals." Nitrous acid when it has once combined with sulphuric acid is therefore fixed, but it remains to be explained how nitrous acid is formed in the towers. Various practical observations have given us a clue. We have remarked that the proportion of nitrous acid flowing from the towers is so much the lower as the working of the chambers is more nitrous—a fact which appears anomalous. The loss of nitrous products diminishes in the same porportion as the intensity of colouration of the gases entering the tower. On examining these gases carefully we have always found there the presence of a quantity of sulphurous acid, very slight but variable, the co-existence of which with sulphuric acid can only be due to the imperfection of the mixture. Such are the facts which have furnished us with the explanation sought for. The gases in this

place are almost dry, but not absolutely so. The sulphurous acid meeting with hyponitric acid reduces it. This reduction, however, stops at nitrous acid, because this product as soon as formed combines with the sulphuric acid produced at the same time, and yields the stable compound nitroso-sulphuric acid. The reaction takes place between two equivalents of each of these two bodies. One equivalent of nitrous acid is retained whilst the other escapes, to become oxidised afresh, and recommence a little further the same reactions. The sulphuric acid which moistens the coke in the tower has the effect of re-collecting the nitro-sulphuric acid formed in the gases, dissolving it, and bringing it to the bottom of the tower. It has no chemical action except in the exceptional cases where it meets with pre-formed nitrous acid. The nitroso-sulphuric acid being unalterable, the nitrous products are henceforth secure from all attacks. We have pointed out that there remains in the gaseous mixture a very slight quantity of watery vapour. This condition is necessary, as sulphurous and hyponitric acids when perfectly dry do not react with each other, the nitroso-sulphuric compound containing combined water. On the other hand, a slightly larger proportion of water destroys the compound.

If the recovery of the nitrous products is more complete when the gases are scarcely yellowish, this depends on the fact that they contain a proportion of sulphurous acid nearer what ought to be the case. But it is impossible to maintain this state in practice, the least influence modifying it, and rendering it either nitrous or sulphurous, and causing losses in either case. We are led to go on with an excess of nitrogen products, and to lose the quantity of hyponitric acid which has not met with sulphurous acid to combine with. We may therefore say that the weight of the nitrous products retained is proportional to the quantity of sulphurous acid co-existing in the gases at their entrance into the Gay-Lussac condensers.

If this is the case, it is sufficient to restore the just proportion by the direct injection, at the foot of the tower, of sulphurous acid in a suitable hygrometric state, so that the reactions may be complete. The gases then become simultaneously poorer in sulphurous and hyponitric acids, in consequence of the greater and greater perfection of the mixture and of the repeated contacts with acid at 1·689 sp. gr., and if the proportions are well regulated they contain at their exit merely absolutely insignificant traces of either of these two bodies. Such are the conditions which we have realised, and experience has fully confirmed our forecasts. We have thus succeeded in reducing the expense of nitrate to the third of what it had been previously.

The object we had in view was thus attained, but we soon found that the use of this process gave rise to other advantages of great importance. We were no longer liable to those losses which are incurred in working with an excess of nitrous vapours, since we were able to re-establish the equilibrium in the composition of the gases at any given moment. It results that we could expedite the reactions, obtain the highest possible yield of sulphuric acid, and increase the weight of pyrites burnt in a plant of a given size. Thus, at the Javal Works, where we made these trials, we succeeded in burning 2·400 kilos. pyrites per cubic metre of chamber-room, without injuring the yield of sulphuric acid or increasing the outlay in nitrate. —*Comptes Rendus.*

Researches on the Relative Intensities of the Rays of Hydrogen and Nitrogen: Application to the Constitution of the Nebulæ.—C. Fievez.—The characteristic rays of the spectra of gases disappear one after the other on gradually reducing the intensity of the light. With hydrogen the rays II and C disappear successively; F remains alone. With nitrogen Plücker's groups I., III., V., II., disappear, and the spectrum is reduced to the group IV., which, with the ray F, constitutes the spectrum of the nebulæ.—*Les Mondes.*

SODIUM HYDROSULPHITE, AND ITS APPLICATION IN THE QUANTITATIVE DETERMINATION OF THE DISSOLVED OXYGEN IN WATER, OF COPPER, OF INDIGO, AND OTHER COLOURING MATTERS.

By A. BERNTHSEN.

The composition of the hydrosulphite is not yet demonstrated to be in accordance with the formula SO_2NaH. It is more probable that the sulphur is present as—

$$SO_2H_2(=SO+H_2O),$$

just as in hyposulphurous and pentathionic acids.

The crude solution of hydrosulphite is already utilised in indigo-dyeing, and is applied in several analytical processes. The method proposed by M. A. Müller (*Bulletin Soc. Ind. Mulhouse*, 1874, 22), for the quantitative determination of indigo, is based upon the reduction of indigo-carmine by means of this salt, as also is the process for estimating the quantity of free oxygen dissolved in water, as devised by Schützenberger and Risler, and improved by Tiemann and Preusse. Cupric salts in ammoniacal solution, are reduced by hydrosulphite, first to cuprous salts (or on further addition to copper hydride and sulphide). The chemists above mentioned, therefore, determine the standard of the hydrosulphite solution by titrating it with a solution of copper sulphate containing excess of ammonia. According to Schützenberger hydrosulphite may also be used for the volumetric determination of copper in cupric salts.

I have also made use of this method of titration by means of an ammoniacal solution of copper, in the frequent determination of the actual proportion of hydrosulphite in a solution. Its admissibility seems to me, however, doubtful, as I found that the hydrosulphite solutions prepared according to Schützenberger, according to my experiments, contained relatively large quantities of sulphite and hyposulphite, both which salts have a reducing action upon copper oxide. It appeared that the addition of a large excess of a sulphite or hyposulphite certainly effected a considerable decrease of the proportion of oxide in a copper solution or even produced complete reduction. But under the circumstances which come into play in the titration, such a disturbing action does not prevail, because the duration of the reaction of the salts is too short, the large excess requisite is not present, and lastly, because the hydrosulphite acts immmediately reductive. Experiment showed that the error occasioned by the presence of sodium sulphite and hyposulphite scarcely exceeds the limit of errors of observation. Another circumstance was calculated to make the results of a hydrosulphite titration by means of a copper solution less accurate—the difficulty of observing the final reaction with sufficient distinctness. According to Tiemann and Preusse, the hydrosulphite should be run into the copper solution (in an atmosphere of hydrogen) till the colour completely disappeared, the oxide being entirely reduced to suboxide (*Berichte*, xii., 1777). The final point is said to be distinctly perceptible. According to another statement (*Bulletin Soc. Chimique*, xx., 145), the appearance of a faint yellowness,—the begining of the separation of copper or copper hydride—shows the final reaction. To reach this point, 0·1 to 0·2 c.c. hydrosulphite solution must be added after complete decolouration.

I did not succeed in obtaining concordant results in this manner, since the end of the reaction, total decolouration, was not readily to be distinguished, and the yellow tint sometimes appeared only on the addition of a decided excess of hydrosulphite. Goppelsröder, in his critique on Müller's process (*Bull. Soc. Ind. Mulhouse*, 1873, 643), observed that the quantities of hydrosulphite consumed in decolourising 20 c.c. of the copper solution varied by 0·5 to 1·6 c.c., equal to 4 to 15 per cent. He therefore proposed to determine the value of the hydrosulphite by means of permanganate, which oxidises it to sulphuric acid,

and in this manner he obtained concordant figures. F. Mohr, J. König, and C. Krauch employ iron-ammonium alum instead of the copper solution. The liquid is coloured red with potassium sulphocyanide and becomes colourless on the completion of the reduction. As I have found that the hydrosulphite solution contains also sulphites and hyposulphites, it is plain that the use of permanganate for the determination of its value must lead to totally false results. Special experiments must decide how far iron-ammonium alum may be fit for use under these circumstances.

I have succeeded in modifying the titration of hydrosulphite with copper solution in such a manner that the final reaction can be conveniently and distinctly observed. The preparation of the standard liquids is the same as recommended by Tiemann and Preusse, and the apparatus employed is very similar to theirs. The hydrogen, after passing through a U-tube containing ferrous oxide enters a three-necked bottle holding about 200 c.c. on one side and takes its exit on the other side through a tube which passes in a little below the cork, bends down again and passes to the bottom of a small test-tube, which is firmly fixed to the apparatus and filled with water. In the central tubulure of the bottle is a caoutchouc stopper with two perforations, in which are secured two glass tubes, narrowed below and fitting well. These are connected with two burettes by means of flexible tubes, 2 c.m. in length, fitted with glass-rod pinch-cocks. In this manner the vessel is movable and its contents may be shaken. The one burette is filled with a dilute solution of indigo-carmine (Tiemann and Preusse's strength). The latter burette is connected above with a flexible tube leading to the gas-tube, and a tube joined to it laterally below, enables it to be filled with fresh hydrosulphite from a store-bottle also connected with the the gas. The gas employed must pass through a tube charged with pumice and ferrous oxide. 15 or 25 c.c. of copper solution are put into the three-necked bottle, the caoutchouc stopper is put in its place, the bottle is filled with hydrogen, and hydrosulphite solution is then gradually run in till the liquid is scarcely blue. A drop or a few drops of indigo-solution are then added from the other burette. The liquid takes a dirty blue colour, and on the further addition of hydrosulphite, this colour is suddenly and sharply changed by the last drop to a pure light yellow. There is no turbidity or precipitation. — *Berichte der Deutsch. Chem. Gesellschaft.*

THE TITRATION OF HYDROSULPHITE BY MEANS OF INDIGO-CARMINE, AND THE QUANTITATIVE DETERMINATION OF INDIGO BY MEANS OF HYDROSULPHITE.

By A. BERNTHSEN and A. DREWS.

For the titration of sodium hydrosulphite a dilute solution of extract of indigo may be used instead of an ammoniacal solution of copper. It is decolourised by hydrosulphite, its deep blue colour passing into a pale yellow, more or less pure. The change of colour, after a little experience, is easily recognised; solutions which are nearly neutral pass from blue through greenish to yellow; but if alkaline they become first violet, then red, and lastly yellow. M. A. Müller proved that in this reaction sodium hydrosulphite converts indigo extract quantitatively into sodium disulpho-leukindigotate. He also ascertained that to decolourise two molecules of copper sulphate the same quantity of hydrosulphite solution is required as to convert one molecule disulphindigotic acid into the corresponding leuco-compound. The authors confirm this statement.

It is most convenient to determine the strength of the indigo solution, prepared from 100 grms. commercial extract of indigo and 2 litres water, with a hydrosulphite solution of known strength. Thus if 20·41 c.c. of indigo solution require 13·3 of a solution of hydrosulphite, of which 35·75 c.c. decolourise 20 c.c. of a solution of copper (4·5346 grms. $CuSO_4+5aq$ in 1 litre), 1 c.c. of the indigo solution corresponds to 0·456 m.g. hydrosulphite if we accept the formula SO_2Na_2.

Or we may dissolve 1·191 grm. of dry chemically pure indigotin in a minimum of sulphuric acid, neutralise with sodium carbonate, and dilute to 1 litre. 2 c.c. of this solution correspond to 1 m. hydrosulphite. This method is rather inconvenient, because in using a minimum of sulphuric acid a portion of the indigo may remain unacted upon, or may form the sparingly soluble mono-sulphindigotic acid, whilst in presence of more sulphuric acid the sodium sulphate formed by its neutralisation is apt to cause a partial precipitation.

With respect to the details of the execution of the process the authors refer to the memoir of Tiemann and Preusse (*Ber. der Deutsch. Chem. Gesell.*, xii., 1868). The apparatus employed is the same as the one above described for the titration of copper, and the operation is conducted at a temperature of 40° in an atmosphere of nitrogen, from 30 to 40 c.c. of recently boiled water being first run in. Several successive determinations can be made without renewing the water, and the modification of the process suggested by König and Krauch obviates the trouble of emptying the Woolfe's bottle and re-filling with hydrogen.

The utility of the process for the determination of commercial indigo has been carefully tested. The great untrustworthiness of the oxidation process depends on the uncertainty how oxidising agents, *e.g.*, permanganate, behave with the organic matters present in crude indigo. A similar doubt obtains concerning the reduction process with hydrosulphite. The authors examined three samples of indigo (*a*, *b*, *c*), dissolving them first in sulphuric acid, and calculating the proportions of indigo from the quantity of hydrosulphite consumed. Portions of the indigo solutions were then used for dyeing wool so as to exhaust the colour, and the residual liquids were again titrated with hydrosulphite: *c* showed 71·7 per cent of indigo, *b* 97·5 per cent; *a* could only be determined very approximately, owing to the presence of dark colouring matters, not decolourised by the hydrosulphite, which masked the final reaction. The residual liquids left from dyeing wool were faintly yellow in case of *b* and *c*, and reddish brown in *a*. Their action upon hydrosulphite was quite insignificant. Admixtures other than dyes do not, therefore, in the hydrosulphite process require to be taken into account as possible sources of error.

The leukindigotic solutions produced by titration—the concentration being equal—appear darker the more impure the indigo, so that the hydrosulphite is probably without action upon the other colouring matters which accompany indigotin. Titration with hydrosulphite, therefore, may show the true proportion of indigotin in indigo. But as the other colouring matters which accompany indigo in commercial samples have a decided effect upon the value of the shades produced in dyeing, the common method of swatch-dyeing must be pronounced the only process which leads to practical results.

In case of homogeneous colouring matters which are contaminated merely with non-tinctorial substances, such as heavy spar and starch, the determination with hydrosulphite is to be recommended, and its applicability to the commercial testing of aniline colours deserves examination.—*Berichte der Deutschen Chemischen Gesellschaft.*

Rufigallic Acid and Oxyquinon.—Dr. J. Schreder. —The fusion of rufigallic acid with 6 parts of caustic potassa takes place less tumultuously than was affirmed by M. Malin, and does not yield a notable quantity of humous matters. Several substances are obtained by fractional crystallisation, and by the precipitation of the ethereal extract by a salt of lead. The least soluble of these bodies is oxyquinone.—*Les Mondes.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, February 12, 1881.

Prof. W. G. Adams in the Chair.

This being the annual general meeting the yearly report was read by the Chairman. The report showed that the Society now numbered 321 Members as against 298 of last year. Two eminent Members, Sir T. H. Elliot and the Rev. Arthur Rigg, had been lost by death. The Society had decided to republish the scientific papers by Dr. Joule in a collected form.

Dr. Atkinson, Treasurer, read the balance-sheet for the past year, which showed the Society to be flourishing.

The new Council and Officers where then elected, Sir W. Thomson retaining the Presidency. Mr. Bakewell and Herr G. Wiedemann were created Honorary Members. Votes of thanks were passed to the Lords Commisioners of the Council on Education for granting the use of the meeting-room to the Society; to Prof. Adams; to Dr. Guthrie, the Demonstrator; the Auditors; and the Secretaries, Profs. Reinold and Roberts.

The meeting was then resolved into a special general meeting, and a resolution put and carried, giving the Council power to invest money of the Society in the name of the Society, or of persons appointed by them, in certain Stock, home and foreign.

The meeting was then constituted an ordinary one, and Mr. T. Wrightson, C.E., read a paper by Prof. Chandler Roberts and himself "*On the Density of Fluid Bismuth.*" By means of the oncosimeter—an instrument which records on a band of paper the sinking or floating effect of a ball of the solid metal immersed in the molten metal—they had determined the density of fluid bismuth, from six experiments, to be 10·055. A former value by a different method was 10·039.

In the discussion which ensued Mr. Wrightson stated that his experiments proved solid cast-iron to be heavier than fluid, and to sink in the latter when first immersed, but it rapidly became lighter as the temperature rose till it floated when in its plastic state, and was consequently lighter than when in the molten state. The oncosimeter could be utilised for determining the change of volume in melting rocks, and Prof. Chandler Roberts suggested that it might throw light on the difference of state between the carbon of grey pig and white iron.

Dr. O. J. Lodge exhibited working models showing the hydrostatic analogies between water and electricity. A battery was represented by a pump, conductor by open pipes, dielectrics by a pipe closed by an elastic membrane, and electrometers by pressure-guages. With these analogues he showed the action of a Leyden jar, and the passage of telegraphic signals along a cable.

CORRESPONDENCE.

SOCIETY OF CHEMICAL ENGINEERS.

To the Editor of the Chemical News.

Sir,—In reply to your correspondent "J. H." (Chemical News, vol. xliii., p. 59), will allow me to state that at the last general meeting, held at the Victoria University, a sub-committee was appointed to draw up rules, &c., and to make preparations for holding the inaugural meeting in the spring. If J. H. will send me his address, I shall be happy to let him know when this meeting will be held.—I am, &c.,

George E. Davis, Hon. Sec. *pro. tem.*

Heaton Chapel, February 4, 1881.

BLEACHING-POWDER.

To the Editor of the Chemical News.

Sir,—In reply to Mr. Kingzett's questions (Chemical News, vol. xliii., p. 59), I beg to state that I am endeavouring once more to get his crystallised calcium hypochlorite, by minutely observing his prescriptions. The results will be mentioned when I publish the experiments on bleaching-powder now going on in my laboratory.

I still fail to see how the strictest proof of the existence of calcium hypochlorite in solutions of bleaching-powder, can be quoted as proving the formula of Odling, which does *not* assume that compound in dry bleaching-powder, against that of Gay-Lussac, which *does* do so. But further discussion on this point seems to me to possess but little interest for your readers.—I am, &c.,

George Lunge.

Zürich, Feb. 11, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 3, January 17, 1881.

Contemporaneous Production of Native Sulphur in the Sub-soil of Paris.—M. Daubrée.—Abundance of native sulphur has been found in the soil in certain excavations which have been lately made in the Place de la Republique. The origin of this substance is perfectly independent of the escape of coal-gas, and is evidently due to the simultaneous presence of gypsum and of organic matter of various kinds.

Production of Intermittent Signals by means of the Electric Light.—E. Mercadier.—This memoir requires an illustration which appears to have been omitted.

Observations on a Recent Communication by M. Dunand on a Process for Reproducing Speech by means of Electric Condensers.—C. Herz.—A claim of priority.

Certain Facts towards the History of Nitrification. MM. Hautefeuille and Chappuis.—Effluves corresponding to very feeble tensions are capable of forming nitric acid as the ultimate product of the decomposition of pernitric acid.

Studies on the Peat of the Crystalline Soils of Finistère.—M. de Molon.—The author has examined this peat as a material for the production of lighting-gas. He distils the peat in a vacuum at 300°, and under the influence of a current of superheated steam. The yield per 100 kilos. of peat was:—

Paraffin and pseudo-paraffin	8·840
Light oil (benzene, toluene)	1·100
Photogenic oil	4·732
Crude phenols	2·000
Resinous matters, methylic, and aromatic products, pitch, &c.	2·740
	19·412

Charcoal, per 100 kilos. of turf.. ..	45	kilos.
Sulphate of ammonia, per 1000 kilos.	10	,,
Monohydrous acetic acid ,, ,,	11 to 12	,,

Portions of the Pancreas Capable of Acting as Ferments.—A. Béchamp.—All the known properties of the pancreas are concentrated in certain microzymas.

No. 4, January 24, 1881.

Theory of Heat.—H. Resal.—A mathematical paper, not capable of useful abstraction.

Selection of the Unity of Force in Absolute Electric Measurements.—M. Lippmann.—The author considers that in some cases the dyne presents no essential advantage. It is very desirable that the units which serve to measure time, lengths, and forces, should be the same in electricity as in the rest of physics. It is suggested that electricians should take as fundamental unities the second, the metre, and the gramme.

Laws of the Disengagement of Electricity by Pressure in Tourmaline.—MM. Jacques and Pierre Curie.—The authors announce the following laws as resulting from their experiments:—The two ends of a tourmaline evolve quantities of electricity respectively equal, but of opposite signs. The quantity liberated by a certain increase of pressure is opposite in its sign, but equal to that produced by an equal decrease of pressure. This quantity is proportional to the variation of the pressure, independent of the length of the tourmaline, and for one and the same variation of pressure per unit of surface it is proportional to the surface.

Baryta employed in Obtaining Arsenic from Arsenious Acid and Arsenic Sulphides.—C. Brame.—In forensic chemistry, for the reduction of arsenious acid, it is common to employ potassium cyanide, or lamp-black heated and mixed with potassa. These bodies have the great disadvantage of containing deliquescent matter, which, on the one hand, interferes to some extent with the reaction, and on the other hand, gives off watery vapour in sufficient quantity to fracture the red-hot test-tubes by its condensation. For forty years the author has employed baryta, which, though hydrated and in powder, does not present these inconveniences; the reaction manifested by the mixture of powdered arsenious acid and baryta heated to redness is instantaneous, and is not accompanied by any disengagement of moisture. The ring formed has a perfectly metallic appearance. There is formed, besides metallic arsenic, barium arseniate, which, if dissolved in nitric acid, gives a red precipitate with silver nitrate. Analogous, but less distinct, results are obtained with lime, potassa, and soda. Arsenic sulphides yield likewise arsenic with baryta, but less easily than arsenious acid. In case of orpiment there is deflagration. On causing chlorine to act upon the arsenical rings obtained in Marsh's modified apparatus, there is formed arsenic perchloride, which, by the action of air and moisture, is transformed into hydrochloric and arsenic acids.

Action of Dry Carbonic Acid upon Quicklime.—F. M. Raoult.—A fragment of dry quicklime, heated to about the melting-point of glass and exposed to a current of pure, dry carbonic acid, absorbs the gas with great energy, becoming incandescent. It is necessary that the lime should not contain more than from 2 to 3 per cent of foreign matter, and that it should not have been burnt at too high a temperature. The compound produced is a bibasic calcium carbonate. It is practically impossible to produce the neutral carbonate by direct synthesis. If lime has been burnt at temperatures exceeding 1100° it absorbs carbonic acid very slowly, and appears as if its molecules had been condensed and in some sort polymerised by the heat.

The Losses of Nitrous Compounds in the Manufacture of Sulphuric Acid, and a Means for their Decrease.—MM. Lasne and Benker.—Inserted at length.

Resistance of Tempered Glass to Flexion.—M. de la Bastie.—It appears that the elasticity of tempered glass is more than doubled. Plain glass tempered has a resistance about two and a half times greater than ordinary double glass. "Half-double" glass tempered has about 3·1 times more resisting power than ordinary double glass.

Cholesten. — W. E. Walitzky. — This compound, $C_{26}H_{42}$, is a white amorphous powder, almost insoluble in alcohol, but soluble in ether. It resembles *c.* cholesterin in its physical and chemical properties.

The Preparation of Crotonic Aldehyd.—M. Newbury.—The author by the process of M. Wurtz has obtained from 100 to 125 grms. crotonic aldehyd from 1 kilo. of paraldehyd.

Moniteur Scientifique, Quesneville.
September, 1880.

Use of the Salts of Vanadium in the Arts.—This paper, a compilation by the Swedish Vanadium Company, Aktie Bolaget Urda, of Stockholm, contains some important information on aniline-blacks. For an aniline-black which does not turn green, which requires no subsequent treatment liable to degrade the black and soil the whites, the following process is recommended:—

Water	5500 grms.
White starch	1250 ,,
Dark calcined do.	420 ,,
Boil, and when cooled down to 50°, add—	
Aniline oil (of d'Andiran and Wegelin, Mulhouse)	800 ,,
Hydrochloric acid, 21° B..	800 ,,
When cold add further—	
Sodium chlorate..	420 ,,
Boiling water	500 ,,
And, at the moment of using, add—	
Vanadic solution, 10 grms. per litre..	200 ,,

The goods are aged for two days, passed through bichromate solution at 5 grms. per litre at 70°, and soaped. Instead of adding to the aniline oil the above-mentioned proportion of hydrochloric acid it is well to neutralise the aniline by adding the acid gradually, till a few drops of the liquid introduced into a very dilute solution of Paris violet (1 grm. per litre) turns the violet colour to a greenish blue. The "vanadic solution" above mentioned is obtained by dissolving, *e.g.*, 10 grms. ammonium vanadiate in 40 grms. hydrochloric acid, slightly diluted, in a porcelain capsule at a gentle heat, and adding glycerine in small doses, keeping the liquid at a boil till its colour passes to a deep green and all the particles are dissolved. The whole is then made up with water to 1 litre and preserved in a stoppered bottle.

Justus Liebig's Annalen der Chemie,
Heft 1 and 2, 1880.

The Chemical Constitution of Organic Bodies with Reference to their Density and their Power of Refracting Light (Second part).—J. W. Brühl.—The author concludes that the atomic refraction of chlorine, bromine, and iodine is unchangeable, the polyvalent elements only possessing a variable atomic refraction. The influence of the double combination between oxygen and carbon is perfectly distinct from that resulting from the double combination between two carbon atoms. The specific property of refraction of different bodies, and their power of dispersing light, is greatly increased by the double attraction of the carbon atoms, whilst the double combination between carbon and oxygen has very little influence in this respect.

Communications from the Chemical Laboratory at Greifswald.—These communications consist of a paper by H. v. Reiche on Two Azo-disulpho-benzolic Acids, and a memoir by A. T. Neale on Two Azo-sulpho-toluolic Acids.

Dichlor-acrylic Acid.—O. Wallach.—The dichlor-acrylic acid from chloralide is perfectly distinct from that obtained from muco-chloric acid by Bennett and Hill.

Certain Decompositions of Mesoxalic Acid.—Dr. Carl Böttinger.—The decompositions here examined are those produced by the action of water with the aid of heat and by the action of sulphuretted hydrogen.

The Alkaloids of Dita Bark.—O. Hesse.—A minute description of ditamine, echitamine, oxy-echitamine, and echitenine.

Researches from the Chemical Institute of the University of Strassburg.—These communications comprise a treatise by Gustav. Schultz on the constitution of Phenanthrene; and a memoir by H. Schmidt and G. Schultz on Diphenyl-benzols.

The Bark of Alstonia Spectabilis.—O. Hesse.—This bark contains six times as much echitammonium hydroxide as dita bark, and as the effects of this compound upon the animal system resemble those of curare, the bark must be considered poisonous.

Certain Ultramarine Compounds (Third Part).—Karl Heumann.—Pure blue sodium ultramarine if heated with silver solution passes into light yellow silver ultramarine. The composition of the latter was almost identical, though ultramarine from different manufactories was used as a material. The silicate contained in silver ultramarine contains twice as many atoms of silver as the apposited silver sulphide, and on boiling with sodium chloride only the silver in the silicate is replaced by sodium. On fusion with alkaline haloids blue ultramarine free from silver is obtained; a green potassium- and a red lithium-ultramarine can also be obtained. The "blueing" process depends on a conversion of the mono-sulphide combined with the silicate into disulphide by nascent sulphur.

An Aceton Base Containing Sulphur.—W. Heintz.—Not suitable for abstraction.

Heft 3, 1880.

The Ethyl Series of Silicium.—C. Friedel and A. Ladenburg.—The authors, after referring to the opinions of Dumas, Wœhler, and others, on the analogy between silicon and carbon, ask if it is possible to produce compounds in which several atoms of silicon are combined with each other? They then proceed to a description of silicon hexa-iodide, silicon di-iodide, oxalo-silicic acid, silicon hexethyl, and silicon hexa-bromide and hexa-chloride.

The Chemical Constitution of Organic Bodies with Reference to their Density and their Power of Refracting Light (Third Part).—J. W. Bruhl.—The principal conclusions reached by the author are that molecular refractions permit merely the classification of the possible cases of isomerism, in as far as these depend in different manners upon the claims of disposible atomicity; but that closer isomerism, which depends on different arrangement of the atoms, cannot be ascertained by molecular refraction. The indices of refraction of the primary and the normal compounds are greater than those of the secondary and the iso-compounds, and in case of all colours the difference of the indices of two isomers is about equal, and approximately the same as between the coefficients of refraction. The density of the normal compounds is always the greatest. From the circumstance that the specific refringent power of isomeric fatty bodies is equal, whilst their densities and their indices of refraction are different, it follows that the refraction-indices of these substances must rise and fall with the density, *i.e.*, the refraction-indices less unity, or the "refringent powers" are proportional to the specific gravities of these isomers. Normal propan-derivatives, though unsymmetric, have a greater specific gravity than the symmetric iso-propyl derivatives, and this rule is based on the general phenomenon that among isomeric bodies that one possesses the greatest density which consists of an unbroken series of hydrocarbon residues, and whose carbon skeleton extends in an uninterrupted straight line. It may be considered a rule that in isomeric bodies the boiling-points, densities, and indices of refraction behave in an analogous manner, these physical constants becoming smaller the more the structure of the molecules deviates from one direction, and is divided into branches, and that the constants of that isomer are the greatest which forms an unbroken chain of hydrocarbon residues. Among isomeric bodies an equal number of molecules requires so much the longer time to traverse a capillary tube the higher are its boiling-point, its density, and its index of refraction. The molecular volume of isomeric compounds is the greater the shorter the molecule, *i.e.*, the more their structure approaches to a straight line.

Contributions to the History of the Orcines: Betorcinol and some of its Derivatives.—J. Stenhouse and C. E. Groves.—The authors describe the preparation of betorcinol, its tetra-chlor-, brom-, dibrom-, iod-, and nitroso- derivatives, and its acid, the barbatic acid, $C_{19}H_{20}O_7$.

The Phosphorescence of Organic and Organised Bodies.—Bronislaus Radziszewski.—In this interesting and comprehensive paper the author shows that phosphorescence is merely a special case of ordinary combustion.

On Tri-aceton-diamine.—W. Heintz.—An account of the acid and neutral oxalates, and the hydrochlorate of this base.

The Decomposition of Brom-ethyl-acrylic Acid by Caustic Potassa.—A. R. Friedrich.—The author describes the preparation of this acid and examines the accompanying by-products. He states that at high temperatures it is decomposed by potassa, yielding a trace of an acid of high molecular weight, sparingly soluble in water, and perhaps isomeric with dihydrophthalic acid, potassium bromide, potassium carbonate, allylene, marsh-gas, and acetic acid.

The Chemical Constitution of Organic Bodies in Relation to their Density and their Power of Refracting Light.—J. W. Bruhl.—A sequel to the paper noticed above.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 6, October 21, 1881.

Physiological Effects of Glycerin.—MM. Beaumetz and Audigé.—Chemically pure glycerin if injected under the skin of dogs proves fatal within twenty-four hours if the dose reaches 8 to 10 grms. per kilo. of the weight of the animal. The symptoms are comparable to those of acute alcoholism.

A Thermo-electric Apparatus for the Discovery of Local Temperatures.—Dr. P. Redard.—This paper cannot be intelligibly abstracted without the accompanying illustration.

No. 7, October 28, 1880.

On Diffusion.—Capt.—A. d'Obermayer.—It would be expected according to the kinetic theory of gases that the exponent indicating the dependence of the coefficient of diffusion on the absolute temperature would exceed that of the coefficient of the interior friction by unity. According to experiments upon the gases hitherto reputed permanent, the latter exponent has been found approximately = ½, and for the coercible gases = 1.

Imperial Academy of Sciences of Vienna.—Volta's Fundamental Experiment.—Prof. Fr. Exner.—Experiment shows that on the surface which separates two heterogeneous metals no electro-motor force, in the meaning of Volta's theory, enters into activity, but that all the metals in mutual connection are on the same potential level. A new theory of Volta's fundamental experiment admits as the source of the electric excitement, not the electro-motor force of contact, but rather the existence of layers of oxide on the surface of the metals. This view suffices for the explanation of all the phenomena observed by Volta.

Electric Rings.—Prof. E. Reitlinger.—Not suitable for abstraction.

Roasted Coffee.—O. Bernheimer.—By roasting coffee there are obtained first the fatty acids present in the raw beans, then caffeine, and lastly a new substance, the vehicle of the aroma of coffee. The quantity of the volatile caffeine is to that of the unroasted coffee as 0·20 to

100. The new substance (oil of coffee) is a heavy oil which turns yellow on contact with the air. Its composition is $C_8H_{10}O_2$.

Pyrogallic and Gallic Acids.—Prof. Senhofer and Dr. C. Brunner.—Pyrogallic acid if treated with ammonium carbonate yields two acids, $C_8H_6O_7$ and $C_7H_6O_5$. The former of these acids is also obtained by the treatment of gallic acid.

The Refractive Power of Molecules.—J. V Janovsky.—Isomeric bodies have not an equal index of refraction. The formula empirically established by Landolt, Gladstone, and Dale for calculating the molecular refractive power gives an accurate result only in cases where the optical relations of the different series are known.

No. 8, November 4, 1880.

Detection of the Origin of Wools.—M. Levoiturier, of Elbeuf, has succeeded in identifying wools of different growth by means of the insects found in the bales.

Prof. Klebs, of Prague, has discovered peculiar microbia in the remains of patients who have died of typhoid fever. They do not occur in the bodies of persons who have been carried off by other diseases.

No. 9, November 11, 1880.

It is said that certain paper collars and cuffs, which are extensively made in America, have proved poisonous. According to the *Monde de la Science* they contain a notable proportion of arsenic.

Curious Physical Phenomenon.—Dr. Grassi forms an apparatus of three concentric vessels, leaving between them annular spaces of about 2 centimetres. The outer space is filled with oil, and the inner with water. The oil is heated by a gas furnace to above 100°, when the water begins to boil. Oil heated to 150° is then introduced into the central vessel, and falls rapidly to a temperature close upon 100°. He finds that this central oil cools more quickly the greater is the heat of the outer ring of oil.

No. 10, November 18, 1880.

Prof. Chevreul has just concluded his fiftieth annual course of lectures on chemistry applied to the study of organic beings.

An international exhibition connected with electricity will open in Paris, August 1, 1881, and will close on the 15th of November following.

A Novel Actinic Phenomenon.—Dr. Phipson.—The author describes a zinc-white of a dazzling purity obtained by precipitating a solution of zinc sulphate by means of barium sulphide, submitting the precipitate to strong pressure, and igniting it with limited access of air. If any barium sulphide escapes oxidation the white compound, on exposure to the sun, begins to darken, and in about twenty minutes becomes of a deep slate colour. If removed into a dark place it gradually loses colour, and in about five or six hours it becomes again snow-white. This experiment may be repeated with the same specimen as often as desired. Further, this change of colour does not take place under a slip of common glass, whether thick or thin; at most the compound takes a slight yellowish brown colour on exposure to the sun for two hours. The sample on analysis was not found to contain silver or any other substance known as actinic.

Double Refraction.—Prof. V. de Lang.—The theory of Cauchy, which has become of such importance for the interpretation of the phenomena of dispersion does not suffice to explain the laws of refraction as now known. The theory requires modification to be brought into harmony with the results of experiment.

Silver Bromide.—The action of light upon this substance varies according as the bromide is in the state of emulsion in an indifferent medium, like collodion, or in an organic substance readily oxidisable, like gelatine. Temperature, moisture, and mechanical pressure do not appear to have any influence.

Aldehyd Resin.—Dr. G. L. Ciamician.—On submitting this resin to the action of zinc-powder there is obtained a mixture of hydrocarbons, composed of ethyl-benzol, of meta- and para-ethyl-toluide, and of methyl-naphthalide.

Idryle.—Dr. G. Goldschmiedt.—This hydrocarbon combines with chlorine and with two proportions of bromine. Disulpho-idryle, on treatment with potassium, yields a non-crystalline cyanide.

Phenols and Aromatic Acids.—C. Senhofer and C. Brunnet.—On treating orcine with ammonium carbonate there is obtained an acid isomeric with orsellic acid, from which it differs by its slight solubility in water and by taking a blue colour in contact with salts of iron. On dry distillation it is decomposed into orcine and carbonic acid.

NOTES AND QUERIES.

Filter-Papers.—Can any of your correspondents give the name and address of the maker of the genuine Munktell's filter-paper?—A Subscriber.

Action of Radiant Heat upon Gaseous Matter.—Reading with interest the valuable paper of Professor Tyndall, an explanation of a phenomenon I had often noticed dawned upon me. When small bulbs (about three-eighths of an inch) are blown upon thin short glass tubes of small diameter, and the bulb after cooling re-introduced into the flame (Bunsen or blast burner), a loud musical note is *occasionally* produced, which ceases when the glass softens. May not the air-gas flame represent intermitting beams of radiant (or direct) heat, which, by communicating their rapid motion to the *aqueous vapour* sometimes present in the bulb, so produce a violent molecular disturbance, giving rise to sound? May not also the "hydrogen note" derive its great intensity partly to the presence of water vapour?—W. Bettel, Worcester.

Tin Sulphocyanide.—In the Chemical News, vol. xlii., p. 331, I noticed a remark concerning the use of tin sulphocyanate in calico-printing; and, again, in vol. xliii., p. 72, you remark that a note from M. Brandt was read to the Industrial Society of Mulhouse "On the Preparation of Thermic Sulphocyanate by the Double Decomposition of Calcium Sulphocyanate and Thermic Oxalate." I have been working at the subject for some time, and as I cannot obtain a copy of the *Moniteur Scientifique* whence your extract has been taken, may I ask you if there is anything in M. Brandt's note which calls for special attention, either in the preparation of the materials or manipulation? I have found the preparation of stannic oxalate (it does not appear to be a commercial article) the most tedious part of the manufacture. Any information in regard to M. Brandt's note I will feel much indebted for.—John Mac Vine.

MEETINGS FOR THE WEEK.

Monday, 21st.—London Institution, 5.
—— Medical, 8.30.
Tuesday, 22nd.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Society of Arts, 8. "Languages of South Africa," Mr. Robert Cust.
—— Anthropological Institute, 8. "Remarks on Arrow-poisons prepared by some Tribes of North American Indians," W. J. Hoffman, M.D. "The Gauchos of San Jorge, Central Uruguay," David Christison, M.D.
Wednesday, 23rd.—Society of Arts, 8. "River Conservancy," Mr. C. N. Cresswell,
—— Geological, 8.
Thursday, 24th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Drawing Room Music," Prof. Pauer.
—— Society of Arts, 8. "Deep Sea Investigation and the Apparatus used in it," Mr. Buchanan.
Friday, 25th.—Royal Institution, 8. "Excitability in Plants and Animals," Dr. J. S. Burdon-Sanderson, 9.
—— Quekett, 8.
Saturday, 26th.—Royal Institution, 3. "Ancient Egypt," Mr. R. S. Poole.
—— Physical, 3. "On an Integrating Machine," C. V. Boys. "On the Telegraphic Transmission of Pictures of Natural Objects," Shelford Bidwall.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at Robert Rumney's Ardwick Chemical Works, Manchester.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the 'Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

THE CHEMICAL NEWS.

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ON THE

VISCOSITY OF GASES AT HIGH EXHAUSTIONS.*

By WILLIAM CROOKES, F.R.S.

By the viscosity or internal friction of a gas, is meant the resistance it offers to the gliding of one portion over another. In a paper read before the British Association in 1859, Maxwell† presented the remarkable result that on theoretical grounds the coefficient of friction, or the viscosity, should be independent of the density of the gas, although at the same time he states that the only experiments he had met with on the subject did not seem to confirm his views.

An elaborate series of experiments were undertaken by Maxwell to test so remarkable a consequence of a mathematical theory; and in 1866, in the Bakerian lecture for that year,‡ he published the results under the title of "The Viscosity or Internal Friction of Air and other Gases." He found the coefficient of friction in air to be practically constant for pressures between 30 ins. and 0·5 inch; in fact numbers calculated on the hypothesis that the viscosity was independent of the density agreed very well with the observed values.

The apparatus used by Maxwell was not of a character to admit of experiments with much lower pressures than 0·5 inch.

Maxwell's theory, that the viscosity of a gas is independent of the density, presupposes that the mean length of path of the molecules between their collisions is very small compared with the dimensions of the apparatus; but inasmuch as the mean length of path increases directly with the expansion, whilst the distance between the molecules only increases with the cube root of the expansion, it is not difficult with the Sprengel pump to produce an exhaustion in which the mean free path is measured by inches, and even feet, and at exhaustions of this degree it is probable that Maxwell's law would not hold.

The experiments recorded in this paper were commenced early in 1876, and have been continued to the present time. In November, 1876, the author gave a note to the Royal Society on some preliminary results. Several different forms of apparatus have since been used one after the other, with improvements and complexities suggested by experience or rendered possible by the extra skill acquired in manipulation. The earlier observations are now of little value, but the time spent in their prosecution was not thrown away, as out of those experiments has grown the very complicated apparatus now finally adopted.

The Viscosity Torsion Apparatus with which all the experiments here given have been performed, is a very complicated instrument, and cannot be well understood without the accompanying drawings. It consists essentially of a glass bulb, blown with a point at the lower end, and sealed on to a long narrow glass tube. In the bulb is suspended a plate of mica, by means of a fine fibre of glass, 26 inches long, which is sealed to the top of the glass tube, and hangs vertically along its axis. The plate of mica is ignited and lamp-blacked over one-half. The tube is pointed at the upper end, the upper and lower points are 46 inches apart, and are accurately in the prolongation of the axis of the tube. Sockets are firmly fixed to a solid support, so that when the tube and bulb are clamped between them they are only able to move around the vertical axis. The glass fibre being only connected with the tube at the top, rotating the tube on its axis communicates torsion to the fibre, and sets the mica plate swinging on the same axis without giving it any pendulous movement. The diameter of the fibre is about 0·001 inch. The viscosity apparatus is connected to the pump by a flexible glass spiral, so as to allow the apparatus to rotate on the pivots and at the same time to be connected to the pump altogether with sealed glass joints. An arm working between metal stops, limits the rotation to the small angle only which is necessary.

The torsional movement given to the mica plate, by the light of the candle shining on it or by the rotation of the bulb and tube on its axis by the movement of the arm between the stops, is measured by a beam of light from a lamp, reflected from a mirror to a graduated scale.

The pump employed has already been described. The measuring apparatus is similar to that described by Prof. McLeod* before the Physical Society, June 13th, 1874. As it contains several improvements shown by experience to be necessary when working at very high vacua, a detailed description is given in the paper.

When taking an observation the arm is moved over to the stop, and in a few seconds allowed to return to its original position by the action of a spring. This movement rotates the viscosity apparatus through a small angle, and sets the mica plate vibrating, the reflected line of light traversing from one side of the scale to the other in arcs of diminishing amplitude till it finally settles down once more at *zero*.

The observer watching the moving index of light records the scale number reached at the extremity of each arc. The numbers being alternately on one and the other side of zero are added two by two together, to get the value of each oscillation. The logarithms of these values are then found, and their differences taken; the mean of these differences is the logarithmic decrement per swing of the arc of oscillation. For the sake of brevity this is called the log dec.

A very large number of experiments have been made on the viscosity of air and other gases. Observations have been taken at as high an exhaustion as 0·02 M, but at these high points they are not sufficiently concordant to be trustworthy. The pump will exhaust to this point without difficulty if a few precautions are taken, but at this low pressure the means of measuring fail in accuracy.

The precautions which experience shows to be necessary when exhausting to the highest points are fully described in the paper.

Viscosity of Air.

The mean of a very large number of closely concordant results gives as the log decrement for air for the special apparatus employed, at a pressure of 760 millims. of mercury and a temperature of 15° C., the number 0·1124. According to Maxwell the viscosity should remain constant until the rarefaction becomes so great that we are no longer at liberty to consider the mean free path of the molecules as practically insignificant in comparison with the dimensions of the vessel.

The author's observations show that this theoretical result of Maxwell's is at least approximately and may be accurately true in air up to such exhaustions as are above referred to; and that at higher exhaustions the viscosity falls off, as it might be expected to do according to theory.

The results are embodied in a table and diagrams.

The first half of the table gives the viscosity of air, in so far as it is represented by the log dec., at pressures intermediate between 760 millims. and 0·76 millim. (1000 millionths of an atmosphere). In order to avoid the inconvenience of frequent reference to small

* Abstract of a Paper read before the Royal Society, February 17, 1881.

† Phil. Mag., 4th Ser., vol. xix., p. 31.

‡ Phil. Trans., 1866, Part 1, p. 249.

* Philosophical Magazine, vol. xlviii., p. 110, August, 1874.

fractions of a millimetre, the millionth of an atmosphere* (=M) is now taken as the unit instead of the millimetre. The second half of the table is therefore given in millionths, going up to an exhaustion of 0·02 millionth of an atmosphere.

Starting from the log dec. 0·1124 at 760 millims., the viscosity diminishes very regularly but at a somewhat decreasing rate. Between 50 millims. and 3 millims. the direction is almost vertical, and a great change in the uniformity of the viscosity curve commences at a pressure of about 3 millims. At this point the previous approximation to, or coincidence with, Maxwell's law begins to fail, and further pumping considerably reduces the log decrement.

From 1000 M the diminution of viscosity is very slight until the exhaustion reaches about 250 M; after that it gets less with increasing rapidity, and falls away quickly after 35 M is reached.

The curves of increasing mean free path and diminishing viscosity closely agree. This agreement is more than a mere coincidence, and is likely to throw much light on the cause of viscosity of gases.

In the table is also given the measurements of the repulsion exerted on the blackened end of the mica plate by a candle-flame placed 500 millims. off. The repulsion due to radiation commences just at about the same degree of exhaustion where the viscosity begins to decline rapidly, and it principally comes in at the exhaustions above 1000 M.

The close agreement between the loss of viscosity and the increased action of radiation is very striking up to the 35 millionth, when the repulsion curve turns round and falls away as rapidly as the viscosity.

Experiments are next described on the resistance of air to the passage of an induction spark.

Since the publication of the author's researches on the phenomena presented by the passage of the induction discharge through high vacua, the present results—which, although never published, precede by a year or two those just mentioned—have lost much of their interest.

The phenomena at the very high exhaustion of 0·02 M may be of interest. With a coil giving a spark 85 millims long, no discharge whatever passes. On increasing the battery power till the striking distance in air was 100 millims. the spark occasionally passed through as an intermittent flash, bringing out faint green phosphorescence on the glass round the end of the — pole.

On one occasion the author obtained a much higher exhaustion than 0·02 M. It could not be measured, but from the repulsion by radiation and the low log dec. it was probably about 0·01 M. The terminals of the vacuum tube and wires leading to them were well insulated, and the full power of a coil giving a 20-inch spark was put on to it. At first nothing was to be seen. Then a brilliant green light flashed through the tube, getting more and more frequent. Suddenly a spark passed from a wire to the glass tube, and broke it, terminating the experiment.

Since these experiments vacua have frequently been got as high, and even higher, but the author has never seen one that would long resist the 20-inch spark from his large coil.

Viscosity of Oxygen.

The series of experiments with air show a complete history of its behaviour between very wide limits of pressure. It became interesting to see how the two components of air, oxygen and nitrogen, would behave under similar circumstances. Experiments were therefore instituted exactly as in the case of dry air, but with the apparatus filled with pure oxygen.

The results are given in the form of tables and plotted as curves on diagrams.

The figures show a great similarity to the air curve. Like it the log dec. sinks somewhat rapidly between pressures from 760 millims to about 75 millims. It then remains almost steady, not varying much till a pressure of 16 millims. is reached. Here, however, it turns in the opposite direction, and increases up to 1·5 millim. It then diminishes again, and at higher exhaustions it rapidly sinks. This increase of viscosity at pressures of a few millimetres has been observed in other gases, but only to so small an extent as to be scarcely beyond the limits of experimental error. In the case of oxygen, however, the increase is too great to be entirely attributable to this cause.

Oxygen has more viscosity than any gas yet examined. The viscosity of air at 760 millims. being 0·1124, the proportion between that of air and oxygen, according to these results, is 1·1185.

This proportion of 1·1185 holds good (allowing for experimental errors) up to a pressure of about 20 millims. Beween that point and 1 millim. variations occur, which have not been traced to any assignable cause: they seem large to be put down to "experimental errors." The discrepancies disappear again at an exhaustion of about 1 millim., and from that point to the highest hitherto reached the proportion of 1·1185 is fairly well maintained.

Viscosity of Nitrogen.

The proportion between the viscosities of nitrogen and air at a pressure of 760 millims. is, according to these experiments, 0·9715.

A comparison of the air curves with those given by oxygen and nitrogen gives some interesting results. The composition of the atmosphere is, by bulk,

Oxygen	20·8
Nitrogen	79·2
	100·0

The viscosity of the two gases is almost exactly in the same proportion: thus at 760 millims—

$$\frac{20{\cdot}8\ vis.\ O + 79{\cdot}2\ vis.\ N}{100} = vis.\ \text{air},$$

$$\frac{20{\cdot}8\ (0\ 1257) + 79{\cdot}2\ (0{\cdot}1092)}{100} = \ ,,$$

$$\frac{2{\cdot}61456 + 8{\cdot}64072}{100} = 0{\cdot}11255,$$

a result closely coinciding with 0·1124, the experimental result for air. Up to an exhaustion of about 30 M the same proportion between the viscosities of air, oxygen, and nitrogen is preserved with but little variation. From that point divergence occurs between the individual curves of the three gases.

Observations on the spectrum of nitrogen are next given.

The curve of Repulsion exerted by Radiation is plotted on the Diagrams. It is much lower than in oxygen or air, and sinks rapidly fter the maximum is passed.

Viscosity of Carbonic Anhydride.

The curves of this gas are given in Diagrams plotted from the observations. At first the curve seems to follow the same direction as the air curve. But at a pressure of about 620 millims. it slopes more rapidly till the pressure is reduced to about 50 millims., when the curve again takes the direction of the air curve. The total diminution between 760 millims. and 1 millim. is nearly double that of air.

The proportion between the viscosity of carbonic anhydride and air at 760 millims. is 0·9208.

Viscosity of Carbonic Oxide.

The results with this gas are remarkable as showing an almost complete identity with those of nitrogen both in position and shape. The viscosity at 760 millims. is in each case 0·1092.

Like that of nitrogen, the curve of carbonic oxide is seen to be vertical,—*i.e.*, assuming the curve to represent

* 1 M=0·00076 millim.; 1315·789 M=1 millim.

the viscosity, the gas obeys Maxwell's law, at pressures between 90 millims. and 3 millims. The straight portion in nitrogen is at a little higher pressure,—between 100 millims. and 6 millims.

The curve of Repulsion resulting from Radiation is lower in carbonic oxide than in any other gas examined, and, unlike the other gases, there is no sudden rise to a maximum at about 40 M. At lower exhaustions the curve is, however, higher than it is in nitrogen.

Viscosity of Hydrogen.

It has been found that hydrogen has much less viscosity than any other gas; the fact of the log dec. not decreasing by additional attempts at purification is the test of its being free from admixture. This method of ascertaining the purity of the gas, by the uniformity of its viscosity coefficient at 760 millims., is more accurate than collecting samples and analysing them eudiometrically.

Several series of observations in hydrogen have been taken. For a long time it was considered that hydrogen, like other gases, showed the same slight departure from Maxwell's law of viscosity being independent of density that appeared to be indicated with other gases; for the log dec. persistently diminished as the exhaustion increased, even at such moderate pressures as could be measured by the barometer gauge. Had it not been that the rate of decrease was not uniform in the different series of observations, it might have been considered that this variation from Maxwell's law was due to some inherent property of all gases. After working at the subject for more than a year, it was discovered that the discrepancy arose from a trace of water obstinately held by the hydrogen. Since discovering this property, extra precautions (already described at the commencement of this paper) have been taken to dry all gases before entering the apparatus.

The remarkable character of hydrogen is the uniformity of resistance which it presents. It obeys Maxwell's law almost absolutely up to an exhaustion of about 700 M, and then it commences to break down. Up to this point the line of viscosity is almost perfectly vertical. It then commences to curve over, and when the mean free path assumes proportions comparable with the dimensions of the bulb, and approaches infinity, the viscosity curve in like manner draws near the zero line.

The repulsive force of radiation is higher in hydrogen than in any other gas. It commences at as low an exhaustion as 14 millims., but does not increase to any great extent till an exhaustion of 200 M is attained; it then rises rapidly to a maximum at between 40 and 60 M, after which it falls away to zero. The maximum repulsion exerted by radiation in hydrogen is to that in air as 70 to 42·6. This fact is now utilised in the construction of Radiometers and similar instruments when great sensitiveness is required.

Taking the viscosity of air at 760 millims. as 0·1124, and hydrogen as 0·0499, the proportion between them is 0·4439.

The Spectrum of Hydrogen.

The red line ($\lambda=6562$), the green line ($\lambda=4861$), and the blue line ($\lambda=4340$) are seen at their brightest at a pressure of about 3 millims., and after that exhaustion they begin to diminish in intensity. As exhaustion proceeds a variation in visibility of the three lines is observed. Thus at 36 millims. the red line is seen brightly, the green faintly, whilst the blue line cannot be detected. At 15 millims. the blue line is seen, and the three keep visible till an exhaustion of 418 M is reached, when the blue line becomes difficult to see. At 38 M only the red and green lines are visible, the red being very faint. It is seen with increasing difficulty up to an exhaustion of 2 M, when it can be seen no longer. The green line now remains visible up to an exhaustion of 0·37 M, beyond which it has not been seen.

It is worthy of remark that although, when working with pure hydrogen the green line is always the last to go, it is not the first to appear when hydrogen is present as an impurity in other gases. Thus when working with carbonic anhydride insufficiently purified, the red hydrogen line is often seen, but never the green or the blue line.

Influence of Aqueous Vapour on the Viscosity of Air.

In the foregoing experiments many discrepancies were traced to the presence of moisture in the gas. The influence of aqueous vapour does not appear to be great when present in moderate amount in gas of normal density, but at high exhaustions it introduces errors which interfere with the uniformity of the results. A series of experiments were accordingly undertaken to trace the special action of aqueous vapour when mixed with air.

Up to a pressure of about 350 millims. the presence of aqueous vapour has little or no influence on the viscosity of air. The two curves are in fact superimposed. At this point, however, divergence commences, and the curve rapidly bends over, the viscosity falling from 0·0903 to 0·0500 between 50 and 7 millims. pressure. Here it joins the hydrogen curve, and between 7 millims. and 1 millim. they appear to be identical.

These results are partly to be explained by the peculiar action of water vapour in the apparatus. At the normal pressure the amount of aqueous vapour present in the air, supposing it to be saturated, is only about 13 parts in a million, and the identity of the log dec. with that of dry air shows that this small quantity of water has no appreciable action on the viscosity. When the pump is set to work the air is gradually removed, whilst the aqueous vapour is kept supplied from the reservoir of liquid. As the exhaustion approaches the tension of aqueous vapour, evaporation goes on at a greater rate, and the vapour displaces the air with increasing rapidity; until, after the pressure of 12·7 millims. is passed, the aqueous vapour acts as a gas, and, being constantly supplied from the reservoir of water (as long as it lasts), washes out all the air from the apparatus, the log dec. rapidly sinking to that of pure water gas.

This explanation requires that the viscosity of pure aqueous vapour should be the same as that of hydrogen, at all events between 7 millims. and 1 millim. pressure. The facts can, however, be explained in another way. During the action of the Sprengel pump sufficient electricity is sometimes generated to render the fall tubes luminous in the dark. It is conceivable that under such electrical influence the falling mercury may be able to decompose aqueous vapour at these high exhaustions, with formation of oxide of mercury and liberation of hydrogen. Of these two theories the latter appears to be the more probable.

The presence of water vapour shows itself likewise in the very slight amount of repulsion produced by radiation. Repulsion commences in air at a pressure of 12 millims., whilst at a higher exhaustion the maximum effect rises to over 40 divisions. Here, however, repulsion does not begin till the exhaustion is higher than the barometer gauge will indicate, whilst the maximum action after long-continued pumping is only 9 divisions.

Viscosity of Kerosoline Vapour.

The rapid diminution of viscosity in the last experiment after reaching the pressure of 400 millims. is probably due to the aqueous vapour in the air being near its liquefying point. It was thought advisable to test this hypothesis by employing a somewhat less easily condensible vapour, which could be introduced into the apparatus without any admixture of air. An experiment was accordingly tried with a very volatile hydrocarbon, commercially known as Kerosoline, boiling at a little above the ordinary temperature. The vapour of this body was introduced into the well-exhausted apparatus, when the gauge at once sank 82·5 millims. After the usual precautions to eliminate air a series of observations were taken.

The loss of viscosity is more rapid than with any other gas examined except aqueous vapour. Conversely a very great increase of viscosity occurs on increasing the pressure from 8 to 82·5 millims. The explanation of this is that the vapour of kerosoline is very near its liquefying point, and therefore very far from the state of a "perfect" gas.

The negative bend in the curve at about 10 millims. pressure, already noticed with other gases, is strongly marked with this hydrocarbon vapour.

Discussion of Results.

When discussing the viscosity results obtained with the different gases experimented with, the author gives the following approximate comparison of viscosities, such as is afforded by a comparison of the log decs. of each gas and that of air, comparing the ratio with that obtained by Graham, Kundt and Warburg, and Maxwell.

	Graham.	Kundt & Warburg.	Maxwell.	Crookes.
Air	1·0000	1·0000	1·0000	1·0000
Oxygen	1·1099	—	—	1·1185
Nitrogen	0·971	—	—	0·9715
Carbonic oxide ...	0·971	—	—	0·9715
Carbonic anhydride	0·807	0·806	0 859	0·9208
Hydrogen	0·4855	0·488	0·5156	0·4439

Graham's numbers are the theoretical results deduced from his experiments on transpiration of gases. They are, he says,* the numbers to which the transpiration times of the gases approximate and in which they have their limit. Graham concludes that the "times of oxygen, nitrogen, carbonic oxide, and air are directly as their densities, or equal *weights* of these gases pass in equal times. Hydrogen passes in half the time of nitrogen, or twice as rapidly for equal volumes. The result for carbonic acid appears at first anomalous. It is that the transpiration time of this gas is inversely proportional to its density when compared with oxygen."

The proportion between air and oxygen, nitrogen, or carbonic oxide is not very different at any degree of exhaustion to that which it is at 760 millims. Carbonic anhydride, however, is different; the proportion between it and air holds good between 760 and 650 millims. Then it gets lower and lower as the pressure sinks, until 50 or 55 millims. is reached, when the proportion between it and air again becomes constant.

Hydrogen, however, is entirely different to the other gases; its log dec. remains the same to a very high exhaustion, and, that of other gases sinking, it is evident that the proportion between this gas and any other is different for each pressure.

It must not be forgotten that the pressure of 760 millims. is not one of the constants of Nature, but is a purely arbitrary one, selected for our own convenience when working near the level of the sea. In the diagrams accompanying the paper the author has started from this pressure of 760 millims., and has given the log. dec. curves which approximately represent the viscosities through a wide range of exhaustion. But the curves might also be continued, working downwards instead of upwards. From the shape and direction in which they cut the 760 line it is reasonable to infer their further progress downwards, and we may assume that an easily liquefiable gas will show a more rapid increase in viscosity than one which is difficult to liquefy by pressure. For instance, hydrogen, the least condensible of all gases, shows no tendency to increase in log dec. by pressure. Oxygen and nitrogen, which are only a little less difficult to condense than hydrogen, show a slight increase in log dec. Carbonic anhydride, which liquefies at a pressure of 56 atmospheres at 15° C., increases so rapidly in log dec. that at this pressure it would have a log dec. of about 1·3, representing an amount of resistance to motion that it is difficult to conceive anything of the nature of gas being capable of exerting.

Kerosoline vapour is rendered liquid by pressure much more readily than carbonic anhydride. Its curve shows a great increase in density for a very slight access of pressure.

Again, aqueous vapour is condensible to the liquid form with the greatest readiness; and the almost horizontal direction of the curve representing aqueous vapour mixed with air carries out the hypothesis.

It follows, then, that Maxwell's law holds good for perfect gases. The disturbing influence spoken of in the commencement of this paper as occasioning a variation from Maxwell's law, is the tendency to liquefaction, which prevents us from speaking of any gas as "perfect," and which hinders it from obeying Boyle and Mariotte's law. The nearer a gas obeys this law the more closely does it conform to Maxwell's law.

Maxwell's law was discovered as the consequence of a mathematical theory. It presupposes the existence of gas in a "perfect" state—a state practically unknown to physicists, although hydrogen gas very nearly approaches that state. An ordinary gas may be said to be bounded, as regards its physical state, on the one side by the sub-gaseous or liquid condition, and on the other side by the ultra-gaseous condition. A gas assumes the former state when condensed by pressure or cold, and it changes to the latter state when highly rarefied. Before actually assuming either of these states there is a kind of foreshadowing of change, with partial loss of gaseity. When the molecules, by pressure or cold, are made to approach each other more closely, they begin to enter the sphere of each other's attraction, and therefore the amount of pressure or cold necessary to produce a certain density is less than the theoretical amount by the internal attraction exerted on each other by the molecules. The nearer the gas approaches the point of liquefaction the greater is the attraction of one molecule to another, and the amount of pressure required to produce any given density will be proportionally less than that theoretically required by a "perfect" gas.

The Ultra-gaseous State of Matter.

After some theoretical considerations respecting the viscosity of gases the author concludes with the detailed statement of his theory of the existence of an ultra-gaseous state of matter.

A consideration of the curves of the gases, especially hydrogen, which are given in the paper, will confirm the supposition that a gas, as the exhaustions become extreme, gradually loses its gaseous characteristics, and passes to an ultra-gaseous state.

An objection has been raised touching the existence of ultra-gaseous matter in highly exhausted electrical tubes, that the special phenomena of radiation and phosphorescence which the author has considered characteristic of this form of matter can be made to occur at much lower pressures than that which exhibits the maximum effects. For the sake of argument let us assume that the state of ultra gas with its associated phenomena is at the maximum at a millionth of an atmosphere. Here the mean free path is about 4 inches long, sufficient to strike across the exhausted tube. But it has been shown by many experimentalists that at exhaustions so low that the contents of the tube are certainly not in the ultra gaseous state, the phenomena of phosphorescence can be observed. This circumstance had not escaped the author's notice. In his first paper on the "Illumination of Lines of Molecular Pressure and the Trajectory of Molecules" * the author drew attention to the fact that a molecular ray producing green phosphorescence can be projected 102 millimetres from the negative pole when the pressure is as high as 0·324 millim., or 427 M. In this case the mean free path of the molecules is 0·23 millim.; and it is not surprising

* *Loc. cit.*, pp. 178, 179.

* Phil. Trans., Part 1, 1879. The Bakerian Lecture.

that with more powerful induction discharges, and with special appliances for exalting the faint action to be detected, the above-named phenomena can be produced at still higher pressures.

It must be remembered that we know nothing of the *absolute* length of the free path or the *absolute* velocity of a molecule; these may vary almost from zero to infinity. We must limit ourselves to the *mean* free path and the *mean* velocity, and all that these experiments show is that a few molecules can travel more than a hundred times the *mean* free path, and with perhaps a corresponding increase over the *mean* velocity, before they are stopped by collisions. With weak electrical power the special phosphorogenic action of these few molecules is too faint to be noticed; but by intensifying the discharge the action of the molecules can be so increased as to render their presence visible. It is also probable that the absolute velocity of the molecules is increased so as to make the mean velocity with which they leave the negative pole greater than that of ordinary gaseous molecules. This being the case, they will not easily be stopped or deflected by collisions, but will drive through obstacles, and so travel to a greater distance.

If this view is correct, it does not follow that gas and ultra gas can co-exist in the same vessel. All that can be legitimately inferred is, that the two states insensibly merge one into the other, so that at an intermediate point we can by appropriate means exalt either the phenomena due to gas or to ultra gas. The same thing occurs between the states of solid and liquid, and liquid and gas. Tresca's experiments on the flow of solids prove that lead and even iron, at the common temperature, possess properties which strictly appertain to liquids, whilst Andrews has shown that liquid and gas may be made to merge gradually one into the other, so that at an intermediate point the substance partakes of the properties of both states.

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*Note on the Reduction of Mr. Crookes's Experiments on the Decrement of the Arc of Vibration of a Mica Plate oscillating within a Bulb containing more or less rarefied Gas.** By Professor G. G. STOKES, Sec. R.S.

THE determination of the motion of the gas within the bulb, which would theoretically lead to a determination of the coefficient of viscosity of the gas, forms a mathematical problem of hopeless difficulty. Nevertheless we are able, by attending to the condition of similarity of the motion in different cases, to compare the viscosities of the different gases for as many groups of corresponding pressures as we please. Setting aside certain minute corrections which would have vanished altogether had the moment of inertia of the vibrating body been sufficient to make the time of vibration sensibly independent of the gas, as was approximately the case, the condition of similarity is that the densities shall be as the log decrements of the arc of vibration, and the conclusion from theory is that when that condition is satisfied, then the viscosities are in the same ratio. Pressures which satisfy the condition of similarity are said to "correspond."

It was found that on omitting the high exhaustions, the experiments led to the following law:—

The ratios of the viscosities of the different gases are the same for any two groups of corresponding pressures. In other words, if the ratios of the viscosities of a set of gases are found (they are given by the ratios of the log decrements) for one set of corresponding pressures, these pressures may be changed in any given ratio without disturbing the ratios of the viscosities.

This law follows of course at once from Maxwell's law, according to which the viscosity of a gas is independent of the pressure. It does not, however, by itself alone prove Maxwell's law, and might be satisfied even were Maxwell's law not true. The constancy, however, of the log decrement, when the circumstances are such that the molar inertia of the gas may presumably be neglected, proves that at any rate when the density is not too great that law is true; and the variability of the log decrement at the higher pressures in all but the very light gas hydrogen is in no way opposed to it, though Mr. Crookes's experiments do not enable us to test it directly, but merely establish a more general law, which embraces Maxwell's as a particular case.

The viscosities referred to air as unity which came out from Mr. Crookes's experiments were as follows:—

Oxygen	1·117
Nitrogen and carbonic oxide ..	0·970
Carbonic anhydride	0·823
Hydrogen	0·500

The viscosity of kerosoline vapour could not be accurately deduced from the experiments, as the substance is a mixture, and the vapour-density therefore unknown. Assuming the relative viscosity to be 0·0380, the vapour density required to make the experiments fit came out 3·408 referred to air, or 49·16 referred to hydrogen.

When once the density is sufficiently small, the log decrement may be taken as a measure of the viscosity. Mr. Crookes's tables show how completely Maxwell's law breaks down at the high exhaustions, as Maxwell himself foresaw must be the case. Not only so, but if we take pressures at those high exhaustions which are in the same ratios as "corresponding" pressures, the log decrements in the different gases are by no means in the ratios of the densities.

It would appear as if the mechanical properties of a gas at ordinary pressures and up to extreme exhaustions (setting aside the minute deviations from Boyle's law, &c.), were completely defined by two constants, suppose the density at a given pressure and the coefficient of viscosity; but that specific differences come in at the high exhaustions at which the phenomena of "ultra-gas" begin to appear; and that, to include these, an additional constant, or perhaps more than one, requires to be known.

* Abstract of a Paper read before the Royal Society, February 17, 1881.

THE DETERMINATION OF SULPHUR IN SULPHIDES AND IN COAL AND COKE.*

By THOMAS M. DROWN, M.D.,
Lafayette College, Easton, Pa.

THE use of bromine as an oxidising agent, particularly for sulphur, has become very general in analysis, replacing the stronger oxidising acids. The object of this paper is to describe briefly the experience which we have gained with this reagent in the laboratory of Lafayette College in the oxidation of metallic sulphides.

Most of the simple sulphides, as blende, pyrites, &c., when exposed to the combined action of an alkaline hydrate and bromine, and finally to hydrochloric acid, are completely and promptly dissolved. The procedure is as follows:—The very finely pulverised mineral is first treated, in a beaker, with a solution of sodium hydrate of a specific gravity of 1·25, and heated; bromine is then cautiously added to supersaturation, and finally hydrochloric acid to acid reaction. If any of the sulphide is not taken up the same operation may be repeated. It is necessary, however, that the mineral be very finely pulverised. Instead of using the pure bromine, a saturated solution of bromine in potassium bromide may be used with equally good effect.

The process is advantageously simplified by making a saturated solution of bromine in the concentrated alkali. This is done by pouring bromine into a solution of sodium

* *Transactions of the American Institute of Mining Engineers.*

hydrate, of the above-given specific gravity, until no more is taken up, and then adding a little of the sodium hydrate solution until the liquid does not give off free bromine. The procedure with this solution is as follows:—The pulverised mineral is moistened with, say, 10 c.c. of the solution, and heated, then hydrochloric acid added to just acid reaction. Two more additions of the alkaline solution, in amounts of 20 c.c. each, are added at intervals of about ten minutes, each addition being followed by hydrochloric acid. The total amount of the alkaline solution (containing the bromine) used is, therefore, 50 c.c., and the amount of hydrochloric acid should not exceed that necessary to make the solution acid after each addition of the alkali. The mixture should be kept hot. After the final addition of acid, the contents of the beaker is taken to dryness and heated in an air-bath to 110° to 115° C., to render silica insoluble. The dry mass is then taken up by hydrochloric acid, and, after filtration, the sulphuric acid is precipitated by barium chloride. In a sample of copper pyrites Mr. F. E. Bachman obtained, in duplicate analyses, 34·05 and 34·12 per cent of sulphur; in zinc blende 32·97 and 33·09 per cent. In another sample of blende Mr. P. W. Shimer obtained 32·71 per cent.

This method of determining sulphur I find especially valuable in the analysis of coal. By the treatment of coal as above described results are obtained which agree very closely. The coal, as such, is not attacked, and the sulphur obtained, therefore, represents that existing in the coal as pyrites, and also as soluble sulphates. The residue left by this treatment has been subjected again to the same process, and yields no more sulphur. On combustion, however, or by complete oxidation, either by oxidising acids or by fusion, additional sulphur may be obtained, which must represent that combined organically with the coal.

The following are some of the results obtained by Mr. Shimer from bituminous coals by the bromine method. The amount usually taken for analysis was between 1 and 2 grms.:—

Bituminous Coals.	Total Sulphur by Fusion with Alkaline Carbonates and Nitrates.	Sulphur by Bromine Process.
I.	0·43	0·035
		0·035
		0·035
II	2·16	1·80
	2·17	1·81
		1·81
		1·83
		1·84
		1·85
		1·87
III.	1·17	0·710
	1·18	0·713
		0·717
IV.	1·48	1·096
	1·49	1·098
	1·50	1·100
		1·100

In comparing the bromine method with others it was found that the treatment with hydrochloric acid and potassium chlorate gave on coals with but little sulphur in the form of pyrites the same results, but on coals with much pyrites the results were decidedly lower than by the bromine method. But too few experiments were tried on this point to be decisive. The action of nitric acid and potassium chlorate depends upon the nature of the coal. Some coals are converted partly into a brown unmanageable solution, and others are oxidised completely to a clear solution. In the latter case, of course, the total sulphur could be obtained.

As was said above, the sulphur obtained by the bromine method represents both the sulphides and sulphates in the coal. The methods ordinarily given for the separate determination of calcium sulphate are faulty. Sodium carbonate readily attacks pyrites, and dilute hydrochloric acid and even water, when heated for some time in contact with pyrites, with access of air, contain notable quantities of sulphuric acid. It would seem, therefore, necessary to dissolve out the calcium sulphate by means of water with the careful exclusion of air.

The determination of the total sulphur in coal by means of fusion with alkaline carbonates and nitrates, or chlorates, I find unsatisfactory, owing, I think, to the large amount of salts in the solution in which the barium sulphate is precipitated. A much better method is to burn the coal in a platinum boat placed in a glass tube in a current of oxygen. The products of combustion may be absorbed by a solution of bromine in hydrochloric acid, or by a dilute solution of potassium permanganate. The latter, I have satisfied myself, gives equally good results with the bromine. It is absolutely necessary, in this process, as originally pointed out by Muck,* that the combustion-tube should be washed out with water after the completion of the combustion, since sulphuric anhydride condenses in considerable quantity in the tube beyond the boat. It is further necessary, of course, to fuse the residual ash with alkaline carbonates to determine the sulphur which has not been volatilised by the combustion.

I have in progress an interesting investigation on the effect of coking on the sulphur in coal, to determine what influence the nature of the sulphur—whether in combination with iron as pyrites or organically combined with the coal—has on its elimination in coking. These results must, however, be reserved for a future communication.

ON THE

CHEMISTRY OF SEWAGE PRECIPITATION.†

By Dr. WILLIAM WALLACE.

(Concluded from p. 68).

The question whether the effluent from precipitation will putrefy and cause a nuisance after mixing with a considerable proportion of clean river water, is one which has engaged my attention, and I am glad to be able to say that the results have been satisfactory. I cannot do better than quote a few sentences from a report I recently made to the Magistrates and Council of Glasgow, and which has been published as an appendix to a report by the deputation which visited a number of English towns last summer.

Experiments were made during July and August on the oxidising power of river water on purified sewage. An average Glasgow sewage was prepared by mixing 2 parts of Portland Street (water-closet) with one part of Reid Street (non-water-closet) sewage, and this was divided into three portions, and defecated—

A. By mechanical means only.
B. By precipitation with lime.
C. By precipitation with sulphate of alumina.

In the effluent the amount of free and organic ammonia was estimated, and 12 parts of clean Clyde water added, after which each sample was divided into two, one-half being placed in an open glass bottle, and the other in a closely stoppered bottle. After the lapse of five weeks, the ammonia was again estimated, when it was found that in every case the oxidation was all but complete, and that it went on as well in closed as in open vessels. The original mixed sewage, or rather the clear portion of it, contained 6·18 grains per gallon of free and 0·233 of organic

* Fresenius, *Zeitschrift*, xiv., 16.

† A Paper read before the Chemical Section of the Philosophical Society of Glasgow, December 6, 1880.

or "albuminoid" ammonia; after treatment with lime the respective quantities were 5·950 and 0·056, and after sulphate of alumina, with a certain quantity of lime (Coventry process), they were 5·880 and 0·042. The following statement shows the proportions of free and organic ammonia in the mixtures of sewage and clean water at the commencement of the experiments and after five weeks:—

	Settling or Filtration.			Purification of Lime.			By Sulphate of Alumina.		
		5 Weeks in			5 Weeks in			5 Weeks in	
	Original.	Open Bottle.	Closed Bottle.	Original.	Open Bottle.	Closed Bottle.	Original.	Open Bottle.	Closed Bottle.
Free Ammonia ..	0·487	0·0024	0·0021	0·470	0·0017	0·0012	0·465	0·0011	0·0011
Organic do. ..	0·023	0·0091	0·0087	0·009	0·0056	0·0053	0·008	0·0049	0·0078
Total	0·510	0·0115	0·0108	0·479	0·0073	0·0065	0·473	0·0060	0·0089

If the proportion of free and organic or "albuminoid" ammonia be accepted as the measure of the amount of pollution, these results shew that in five weeks, at least in the cases where defecation was effected by precipitation, the whole of the added pollution in the form of sewage had disappeared, and the water had acquired a degree of purity equal to that of the Clyde above Glasgow. Even in the sewage purified by filtration, only 2 per cent of the ammonia remained unoxidised. Experiments showed that the ammonia was converted first into nitrous, and finally into nitric acid, combined in both cases, of course, with bases (lime, magnesia, soda). In the case of the filtered sewage, kept in a closed bottle, the amount of nitric acid was found to be 1·63 grs. per gallon, equal to 0·513 of ammonia. The amount of ammonia which had disappeared during the experiment was 0·499, so that it must be concluded that the oxidation had already begun before the original estimation was made. In this series of experiments the effluents obtained by precipitation were practically inodorous, and after being mixed with the Clyde water they did not at any time acquire an appreciable odour. An experiment begun in 1879, in which crude sewage was mixed with 8 times its bulk of clean water, and the mixture kept in a loosely covered vessel, showed that even in a year the impurities did not disappear, and all the time there was abundance of fungoid growth. In none of the experiments where the defecated sewage was mixed with 8 or 12 times its bulk of clean water was there any growth of sewage fungus observed.

An experiment of similar character begun on 12th August showed that, during warm weather at least, the oxidation is very rapid. Some average Glasgow sewage was defecated by lime (in the proportion of one ton per million gallons), and mixed with 12 parts of clean Clyde water, and the result was tested on 1st September, with the following results:—

	Defecated Sewage.	Mixture, 20th August.	1st Sept.
Free Ammonia	5·320	0·4220	0·0014
Albuminoid do	0·063	0·0094	0·0070
Total	5·383	0·4314	0·0084

The mixture on 1st September contained a large proportion of nitrous acid, showing that, although the ammonia had almost disappeared, the oxidation was not yet complete. Subsequent experiments during colder weather showed that the rapidity of the oxidation depends much upon temperature, the process being decidedly slower in cold than in warm weather. If, as is asserted by some authorities, and as my own observations indicate, the process depends mainly upon the presence of *bacteria*, it is easy to understand that the oxidation, or, as it may be called, nitrification, will be more rapid in warm than in cold weather.

The result of all my experiments and observations is that Glasgow sewage, properly defecated and introduced into the Clyde at a point below the City, will not, under any circumstances, give rise to a nuisance.

The question whether lime or alumina is the more effective agent for the precipitation of sewage has engaged my attention, and the results of my observations appear to indicate that, although the alumina produces a somewhat more satisfactory effluent, the advantages obtained by its use are not sufficient to compensate for the greatly increased cost of purification, which may be set down at about four times that of lime. If, however, a very cheap variety of sulphate of alumina, with some sulphate of iron, can be obtained, or if the liquor obtained by lixiviating calcined alum shale is available; if, in fact, the cost of alumina, or a mixture of alumina and oxide of iron, could be approximated to that of lime, I would have no hesitation in recommending its use in preference to lime.

Mr. Peter Spence, of the Pendleton Alum Works, near Manchester, has proposed a very ingenious system for the purification of sewage and the utilisation of one of its constituents. The sewage is first treated with lime, and the nearly-clear effluent mixed with a solution or sulphate of alumina, which throws down albuminous compounds combined with alumina, while at the same time the free lime in the effluent is neutralised. The alumina precipitate is then treated with a sufficient quantity of sulphuric acid to combine with the alumina, forming a sulphate which can be used over again, when the albuminous matter is separated in flakes, which are collected, dried, and distilled, and the ammonia produced converted into sulphate. A careful experiment with one gallon of sewage from Portland Street sewer gave 1·5 grs. of albuminous matter, retaining 0·57, or nearly one-fourth, of the whole alumina, and containing 0·078 of a grain of nitrogen, equal to 0·38 of a grain of commercial sulphate of ammonia. 30 million gallons of such sewage would, therefore, yield by this process 1629 lbs. of sulphate of ammonia, worth about £13. On the other hand, there would be required about £90 worth of sulphate of alumina, a certain portion of which would be lost at each operation, and about £30 worth of sulphuric acid, so that the sulphate of ammonia would not go far in covering the extra expense of the process as compared with a simple precipitation by lime. Besides this, extra tank accommodation to a large extent would be required to work the process, which appears to be of too complicated a character for practical sewage precipitation. It is only right to state, however, that Mr. Spence, in his experiments with Birmingham sewage on a more extensive scale than mine, shows a larger yield of ammonia and less loss of alumina.

A process for the extremely rapid oxidation of the effluent from precipitation by lime or alumina, by which it would be rendered entirely innocuous before being introduced into the river, and that at trifling cost, has been brought before me, but I am not at present at liberty to disclose the name of the inventor or the details of the process. I trust that it will be brought before the Society by the inventor during the present session.

Absorbent Power of some Pulverulent Bodies.—J. G. van Deventer.—Bodies in powder, in the same physical state, have different absorbent powers. The absorbent power increases with the thickness up to a certain limit. For each body there is a stratum of maximum absorption.—*Les Mondes.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 17th, 1881.

Prof. H. E. ROSCOE, President, in the Chair.

AFTER the minutes of the previous meeting had been read and confirmed, the PRESIDENT announced that the following changes had been proposed in the Council, &c., for the ensuing year:—Retiring Members—N. S. Maskelyne and R. Angus Smith from the list of Vice-Presidents:—C. W. Heaton, W. A. Tilden, J. L. W. Thudichum, and C. Graham from the Council. New Members proposed—A. Crum Brown and J. Emerson Reynolds as Vice-Presidents; C. Schorlemmer, G. H. Makins, C. M. Tidy, and F. T. Brown as Ordinary Members of Council. The following gentlemen were then elected as Auditors:—F. J. M. Page, J. M. Thomson, and R. C. Woodcock.

The following certificates were read for the first time:—J. F. Braga, H. Borras, T. C. Day, E. T. G. Gill, P. B. Mills, F. Tiemann, G. Valentine, A. Walker. During the evening a ballot for the election of Fellows was held, and the Scrutators, Drs. Hugo Müller and Stevenson, declared the following gentlemen as duly elected:—B. Akroyd, M. M. Bird, W. E. Benton, H. Baker, M. Benjamin, H. P. Cooper, W. H. Coffin, J. J. Eastick, H. W. Fenner, M. P. Gossett, S. Harvey, J. W. James, T. H. Judson, A. J. King, W. E. Kay, C. A. MacMunn, W. G. McMillan, W. J. Stavert, T. Takamatsu, P. Vieth, G. J. Wishart, R. W. Walker.

The PRESIDENT then called upon Mr. M. W. WILLIAMS to read a paper "*On the Estimation of Organic Carbon and Nitrogen in Water Analysis simultaneously with the Estimation of Nitric Acid.*" Of all the processes in use for estimating the organic matter in water, the safest and most thoroughly scientific in principle is perhaps that of Frankland and Armstrong. To this process as at present worked there are, however, some objections. The time required to evaporate the water is over twenty-four hours. The water is kept for a long time in contact with sulphurous acid, a portion of which may at any time be oxidised to sulphuric acid. There is no test by which to make certain that the nitric acid has been completely destroyed. A correction of some magnitude, calculated by an empirical method, has to be introduced to allow for the dissociation of ammonic sulphite. Moreover, nitrous acid, which is produced by the reduction of the nitrates by the sulphurous acid, attacks ammonia and amidated bodies in acid solution, evolving their nitrogen in the free state, and it is uncertain how far the nitrogen of the ammonia and of the organic matter in a water undergoing evaporation may be attacked in this way. The author proposes to avoid altogether the use of sulphurous acid, and to shorten very considerably the time required for a water analysis. The process consists essentially in converting the nitrates into ammonia by the copper-zinc couple, as described by the author at the previous meeting, distilling off the ammonia with the addition of a little sodium carbonate, and evaporating the residue in the retort to dryness for the combustion. The process may be briefly described as follows:—The zinc-foil is carefully cleansed from grease, &c., by boiling with dilute caustic alkali, and its surface freed from oxide by washing with acidulated water; it is then immersed in 3 per cent copper sulphate solution, as described in the previous paper. The copper-zinc couple is carefully washed, placed in a wide-mouthed stoppered bottle, and the water poured on and allowed to digest at the proper temperature until the reduction of the nitric acid is complete. About 1200 to 1300 c.c. of water are used. As nitrous acid is present in the liquid as long as any nitric acid remains, 100 c.c. of the water are withdrawn, and if a yellow colouration appears in half an hour after adding meta-phenylen-diamine and sulphuric acid a longer digestion is needed. If no colouration appears the reduction is complete. The remainder of the water is poured off from the copper-zinc couple into a tall cylinder, and decanted from any particles of copper and zinc. A litre is distilled in a glass retort until the distillate is free from ammonia, one or two drops of a strong solution of sodium carbonate being added. The ammoniacal distillate is Nesslerised, and, after deducting the quantity of ammonia originally present in the water, gives the quantity of nitric acid present. The water in the retort is further distilled to a low bulk, 200 c.c. Any carbonate of lime deposited is brought into solution by the addition of a little sulphurous acid. The water is then rinsed out into a smooth hemispherical basin, and evaporated to dryness on the water-bath. The residue thus obtained is free from all compounds of nitrogen except the organic matters contained in the water. The combustion of the residue is carried out as prescribed by Frankland and Armstrong. The author has employed the process with many waters having nitrates from 5 to 0·5 parts NO_3 in 100,000: the results agree with those obtained by the sulphurous acid method. The author claims for the process that it is free from the sources of error which accompany the use of sulphurous acid for destroying the nitrates, and that it is more rapid.

Mr. W. THORP asked what precautions were taken to prevent the introduction of organic matter with the copper-zinc couple.

Mr. WILLIAMS said that it was very easy to exclude the possibility of such introduction if care was taken in making the copper-zinc couple.

Captain ABNEY then gave some account of some recent researches which he had carried out in conjunction with Colonel FESTING, "*On the Influence of the Molecular Grouping in Organic Bodies on their Absorption in the Supra-red Region of the Spectrum.*" The authors have photographed the absorption-spectra of numerous inorganic and organic solutions. The electric light was used. The portion of the spectrum photographed was beyond the red, which is of course under ordinary circumstances quite invisible. The focussing of this portion was attended with some difficulty, as nothing could be seen; successive trials had to be made until the photographs came out sharply defined. Three prisms were used, and the thickness of the layer of liquid was about 6 inches. Many of the photographs were thrown on the screen. Many of the organic radicles have in this ultra-red portion of the spectrum characteristic bands, or groups of bands, which run more or less through all their compounds; so that after some experience it is possible to say, from its spectrum, whether or not a chemical compound contains a certain organic radicle. The change produced in the absorption-spectrum of a substance by the addition of oxygen, nitrogen, &c., was pointed out. It is a curious fact that some of the well-marked absorption-bands of the benzene nucleus (857), of alcohol (900), and of water and chloroform (824) agree with some lines of the solar spectrum. The absorption-spectrum of hydrogen seems to be one of lines. The investigation seems likely to throw much light on the internal structure of organic substances.

The PRESIDENT said the subject was one of great interest, and as the investigation was still in its infancy, he must congratulate the authors on the results they had already obtained. As Dr. Russell and Mr. Lapraik had a paper on a somewhat similar subject, he would call on Dr. Russell to give his communication before entering on any discussion.

Dr. RUSSELL then communicated some results obtained by Mr. LAPRAIK and himself, "*On Absorption bands in the Visible Spectrum Produced by Certain Colourless Liquids.*" The authors have carefully drawn the absorption-spectra of these liquids in long tubes (8 to 12 feet) in the visible part of the spectrum. The liquids examined included water, ammonia in solution in water, ether and alcohol, methylamine, &c. The bands in the spectra of ammonia and methylamine seem to be almost identical.

Dr. ARMSTRONG pointed out how remarkably some of

the photographs of Capt. Abney confirmed the views held by chemists as to the constitutional formulæ of organic bodies. These results afforded a proof that a chemical symbol represented not merely the behaviour of a substance, but gave a real picture of its internal structure. The spectrum of turpentine was exceedingly interesting. He should like to ask whether in the spectra of different radicles the bands were harmonics.

Capt. Abney, in reply, said that some of the bands nearly occupied the places of harmonics, but not quite. He should like to thank Dr. Hodgkinson on behalf of Col. Festing and himself for his valuable assistance in procuring the various liquids with which they had experimented.

"*On the Action of Hydrochloric Acid on Ethylene Alcohol*," by C. Schorlemmer. By heating glycol with an excess of fuming hydrochloric acid in a sealed tube to 100°, the author has converted this substance into ethylene dichloride, and has thus disproved the conclusion that the two hydroxyl groups had different functions.

"*On an Attempt to Accelerate the Process of Determining the Soluble Salts in a Soil*," by E. W. Prevost. The author added calcium sulphate and barium carbonate to the soil to expedite filtration, but in neither case were satisfactory results obtained.

The Society then adjourned to March 3, when the following papers will be read:—"On the Action of Bacteria on Various Gases," by F. Hatton; "On the Oxidation of Organic Matter in Water," by C. M. Tidy.

NOTICES OF BOOKS.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. By W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxii., July to December, 1880. London: Simpkin, Marshall, and Co.

This retrospect, valuable as it must be to the medical practitioner, contains but little to interest the chemist or the physicist. Perhaps the most widely-important memoir here quoted is one by Prof. Jos. Lister, F.R.S., on "Micro-organisms and their relation to Disease." Referring to the labours of Pasteur, Toussaint, Greenfield, and others, the author remarks that "if the British Medical Association should meet at Cambridge again ten years hence some one may be able to record the discovery of the appropriate vaccine for measles, scarlet fever, and other acute specific diseases of the human subject. But even should nothing more be effected than what seems to be already on the point of attainment—the means of securing poultry from death by fowl-cholera and cattle from the terribly destructive splenic fever—it must be admitted that we have an instance of a most valuable result from much-reviled vivisection."

An account is given of a remarkable case of hyperpyrexia in a young woman. Her blood temperature rose to 125·5° F., and still she lives and does well!

Year-Book of Pharmacy: comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, from July 1, 1879, to June 30, 1880. London: J. and A. Churchill.

This volume contains an extensive selection of useful matter, most of which, however, as far as pure chemistry is concerned, will be well known to our readers. Some of the extracts placed under the head of pharmaceutical chemistry seem to have no valid title to such a position; *e.g.*, the vapour-density determinations of inorganic bodies at high temperatures, by V. and C. Meyer. Nor do we see why a method for ascertaining the purity of cream of tartar should be included under "Pharmaceutical Chemistry," whilst instructions for the examination of chloroform figure under "Pharmacy." We should venture to suggest that a separate section for analytical chemistry as applied to pharmacy would here be useful.

From the Presidential Address delivered at the last British Pharmaceutical Conference we quote the remark that the "fine old remedies and recipes that people used formerly for their minor complaints have very much succumbed before those all-promising, but mostly delusive, shams called patent medicines"—one of the many questionable features of our boasted "progress."

The most pleasing feature of this book is the proof it supplies how wonderfully the pharmaceutical profession has risen both in status and efficiency since the middle of the century.

CORRESPONDENCE.

ELECTRIC PAPER.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 39, I observe a note on what is called "Wiedemann's Electric Paper." Permit me to point out that most of those who have lectured on electricity for the last thirty years have been in the habit of using what is commonly called "Gun-paper" (pyroxylin made from Swedish filter-paper, a substance at one time largely used in making photographic collodion) for showing experiments in static electricity: I for one constantly employed it. I remember also that Faraday, in a lecture at the Royal Institution, made use of a piece of gutta-percha and a piece of gun-paper (or a film of collodion, I forget now which) as illustrations of the very different composition of substances from which electric sparks could be obtained by friction. The one being so carbonaceous that even in pure oxygen it burnt with a very smoky flame, the other containing so much oxygen that it exploded even in carbonic acid gas. Where is the novelty of M. Wiedemann's electric paper?—I am, &c.,

Chas. Heisch.

BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—The discrepancies experienced in the testing of benzol, referred to by correspondents in recent issues of the Chemical News, are not I believe caused so much by defects or want of uniformity in manipulation, or in the kind of apparatus used,—though no doubt some small differences will arise due to these,—but must be ascribed principally to the neglect by some testers of the effect which the pressure of the atmosphere has on the boiling-points of liquids. Many years ago my attention was directed to the special effect which barometric pressure exercises on benzol, and ever since have made it a rule that its influence must always be considered when taking the boiling-points. The result of my experience is that in testing 30 or 50 per cent benzol 0·8 per cent, or nearly so, must be allowed for every degree which the barometer indicates at the time above or below the standard point. I take 30 inches as the standard, though perhaps 29·5 would be more fair as a medium standard point, but as a seller I prefer to err on the safe side, and take 30 inches.

A few days ago we were delivering some 30 per cent benzol, and as the barometer indicated here at the time of testing 28·6, we were obliged to give 42 per cent up to 100° C., knowing that if a rise in pressure took place, so that the barometer stood at 30 inches when the benzol reached the purchaser's hands, it would show about 30 per cent on testing.

If the barometric pressure is observed, and allowance made as I have briefly described, and ordinary care taken, there will be few disputes arising out of this matter. I have had this mode of testing in application during the last twelve or thirteen years at our works, and have not had one single substantiated complaint during the whole of that time.

The above rule should be applied only to 30 and 50 per cent benzols, to that portion of them which comes over up to 100° C.; the latter part of the distillate, as well as 90 per cent benzol, being affected only to a moderate extent by change of pressure.—I am, &c.,

J. D.

February 15, 1881.

DECOMPOSITION OF SLAGS AND SILICATES.

To the Editor of the Chemical News.

Sir,—I would caution chemists who intend to use the valuable process of Mr. Malvern W. Iles as to the action of caustic alkalies upon silver vessels. Eleven years ago, I worked at an identical process in a laboratory where gas was not obtainable, but had to discontinue the use of silver vessels owing to the complication of obtaining silver in solution, after separation of the silica by hydrochloric acid, by the solubility of chloride of silver in solutions of alkaline chlorides, and the trouble of estimating small quantities of lead and copper in presence of the silver as introduced.

The quantity I used was, however, nearer 5 than 50 grms. caustic alkali for fusions.

Such annoyances attendant upon the use of silver vessels for such fusions led me, some time after, to obtain a gold-lined platinum crucible, which worked admirably with both gas and spirit flames, and served to conduct oxidations with nitre and carbonates, fusions with bisulphates of potash and soda, and alkaline fluorides, as well as being used for general ignitions, roastings, &c., under the melting-point of gold. The price of the crucible was 42s. per oz.; which, considering its usefulness, was not expensive compared with platinum.—I am, &c.,

William Bettel.

Analytical Laboratory and Assay Office,
The Grove, Worcester.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 5, January 31, 1881.

Persistent Vitality of Carbuncular Germs, and their Preservation in Cultivated Soils.—M. Pasteur.—At a farm near Senlis, cattle which have died of carbuncular fever twelve years ago have been buried at a certain spot in a walled garden. Samples of the soil were lixiviated and concentrated, and guinea-pigs inoculated with the matter died quickly with well-marked symptoms of carbuncle. Of seven sheep allowed experimentally to pass a few hours daily on this spot, two died of the same disease in the course of six weeks, whilst the rest of the flock from which the seven had been taken remained healthy.

Action of Hydrochloric Acid upon Metallic Chlorides (a continuation from xci., p. 986).—A. Ditte.—The author examines the case where the presence of hydrochloric acid renders the chlorides less soluble, and which may be divided into two groups; one of these consists of salts very soluble in water, and which are deposited in the state of crystalline hydrates. The presence of hydrochloric acid diminishes notably the weight of chloride dissolved, but still leaves it considerable. The last group consists of chlorides which are almost insoluble in the concentrated acid.

Determination of the Colours Corresponding to the Fundamental Sensations by means of Rotatory Discs.—A. Rosenstiehl.—The author takes as his starting point a chromatic circle, drawn out on paper with 72 colours, the red, yellow, and blue being equidistant from each other, and the intervals filled with colours as equidistant as possible. Each colour may be regarded as a mixture of two others, and the author has undertaken to measure the two components of each. Supposing the orange to be a mixture of red and yellow, the author makes a disc of two concentric circles, the smaller formed of two sectors, the one orange and the other blue. The larger circle consists of a red sector, a white sector, and an empty space representing the absence of light, and they are made to revolve rapidly. The blue sector extinguishes the yellow of the orange and forms white, while the red remains alone. The measure of the two resulting sensations is given by the angle of the red sector and that of the white sector. The author found 140° orange + 220° blue = 218° red + 56° white. In this manner the chromatic circle has been divided into four sections. The line which represents the proportion of the extreme sensations in the intermediate colours is straight. The line representing the sensation of yellowness reaches its culminating point on the ordinate corresponding to the yellow. In the other colours the case is different. The sensation of red goes on increasing in a straight line line from the blue to the red, and continues ascending beyond without deviation as far as the orange, where it attains its culminating point. After this it lowers again as far as the yellow, where it is *nil*.

Determination of Carbonic Acid in the Air.—A. Muntz and E. Aubin.—The authors, after referring to the discordant results obtained in the determination of atmospheric carbonic acid, describe their method. The carbonic acid is fixed by an absorbent body, from which it is afterwards set at liberty and measured by volume. As absorbent they use pumice stone saturated with solution of potassa, and contained in a tube drawn out at both ends. The tubes are washed with sulphuric acid, filled with small fragments of pumice, calcined with sulphuric acid, and introduced while hot. The pumice is saturated with a given volume of potassa lye, operating in air deprived of carbonic acid. The lye is prepared by dissolving 1 kilo. potassa in 1·400 litres of water, and adding 200 grms. hydrated baryta to remove sulphates and carbonates. The tubes, prepared beforehand and sealed, are opened at the place of operation, and sealed again after 200 litres of air have been passed through.

Remarks on M. Eisenberg's Memoir on the Separation of Trimethylamin from the Bodies which Accompany it in the Trimethylamin Hydrochlorate of Commerce.—MM. Duvillier and Buisine.—A critique on a paper in the *Berichte der Deutsch. Chem. Gesel.*, xiii., 1667.

A Process for the Total Destruction of the Organic Matters in the Detection of Poisonous Mineral Substances.—A. G. Pouchet.—From 100 to 500 grms. of the suspected matter are mixed in a large porcelain capsule with one-fourth its weight of the acid sulphate of potassa, and then with its own weight of fuming nitric acid. The action is very violent at first, and requires afterwards the aid of a slight heat. Here it is proper to stop if it is merely needful to search for arsenic or antimony. A large excess of pure concentrated sulphuric acid (1·845 sp. gr.) is then added, and the mixture is heated to near the boiling-point of the acid. More acid is added from time to time till the mixture becomes pale and limpid. To complete the destruction of the last traces of organic matter it is well to let the liquid cool, add a few crystals of pure potassium nitrate, and heat again till abundant white vapours of sulphuric acid are evolved. The saline mass

when cold is dissolved in boiling water, made up to 1 litre, and without previous filtration it is submitted to electrolysis by means of 4 Bunsen elements or a Clamond gas-battery. The negative platinum electrode becomes covered with a grey, blackish, or metallic coating. The action should be prolonged for twenty-four hours. If mercury is suspected a plate of gold should be used at the negative pole instead of platinum. If arsenic or antimony is sought for before the addition of the sulphuric acid, the carbonaceous mass is cooled, powdered, and treated with boiling water. The solution thus obtained is examined as proposed by Dr. A. Gautier (*Comptes Rendus*, August, 1875).

Bulletin de la Société Chimique de Paris.
No. 3, 1880.

Remarks on the Density of the Vapour of Iodine.—J. M. Crafts.—The results obtained by the author are quite comparable with those of M. Victor Meyer, and agree both for the lowest and the highest temperatures, but about 1000° M. Meyer finds the vapour-density of iodine = 5 76 to 6·16, as in his previous determinations, whilst the author obtains at the same temperature a density of about 7,—a discrepancy which he is unable to explain. He suggests certain modifications and precautions by which he hopes to arrive in concert with Prof. Meyer at definitive conclusions.

Action of Oxygenated Water upon Silver Oxide and Metallic Silver.—M. Berthelot.

Silver Teroxide.—M. Berthelot.

Observations on the Decomposition of Potassium Permanganate by Oxygenated Water.—M. Berthelot.—These three papers have been already noticed.

Reply to M. A. Gautier's Observations on the Author's Memoir on Methyl Cyanide.—C. Vincent and B. Delachanal.—The authors show that the question handled in their paper had not, as M. Gautier intimates, been solved previously.

Products of the Action of Soda upon Glycerin.—A. Fernbach.—In preparing propyl-glycol by this reaction, as recommended by Belohoubek, the author obtained as secondary products—methylic alcohol, ethylic, isopropylic, and propylic alcohols, and certain oily products, which from their small quantity could not be exactly separated.

Residues from the Manufacture of Oils from Schists. Gaston Bong.—The solid residues serve for the manufacture of alum, and may become an important source of lithia. The acid tarry matters contain sulphates of the bases of the pyridic series, especially of corindine, rubidine, and viridine. Aniline is not sensibly present. The insoluble portions and the alkaline tars contain peculiar phenols, thymols β and γ. There is no ordinary phenic acid, and very little thymol α.

Preparation of Pure Dimethyl Resorcine.—Oechsner de Coninck.—The author describes his process at length. He describes pure dimethyl resorcine as an oily liquid, colourless or slightly yellowish, of an ethereal odour, boiling at 210° to 212°, and of the sp. gr. 1·075 at 0°.

Bromine Derivatives of Nicotine.—R. Laiblin.—Not suitable for abstraction.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 11, November 25, 1881.

Cork-cutters' waste is recommended as a material for the manufacture of gas.

MISCELLANEOUS.

Obituary.—We regret to have to record the death at Bridge of Allan, on 9th inst., of William Arnot, F.C.S., Analytical Chemist and Chemical Engineer, aged 38 years.

Wilts and Hants Agricultural College, Downton, Salisbury.—Mr. J. M. H. Munro, D.Sc. Lond., F.C.S., has been elected resident Professor of Chemistry in this College, and he will act in co-operation with Professor A. H. Church, M.A. Oxon. Dr. Munro headed the first-class Honours lists in Chemistry, at both the examinations for the B.Sc. Degree, and in 1874 obtained the Chemical Exhibition of the University; he was also classed in Botany and Vegetable Physiology, and in Logic and Moral Philosophy, and took the D.Sc. Degree in 1877. He recently received a grant from the Chemical Society, in aid of a research on which he is at present engaged.

MEETINGS FOR THE WEEK.

MONDAY, 28th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Geographical, 8.30.
TUESDAY, 1st March.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Medical and Chirurgical (Anniversary), 8.30.
—— Society of Arts, 8. "Languages of Africa," Mr. Robert N. Cust.
WEDNESDAY, 2nd.—Society of Arts, 8. "Lighthouse Characteristics," Sir William Thomson, LL.D., F.R.S.
—— Pharmaceutical, 8.
THURSDAY, 3rd.—London Institution, 7.
—— Royal, 4.30.
—— Chemical, 8. "On the Action of Bacteria on Various Gases," Mr. F. Hatton. "On the Oxidation of Organic Matter in Running Water," Dr. C. M. Tidy. "On the Action of Aldehyds on Phenanthrene-quinon in Presence of Ammonia (Second notice)," Dr. F. R. Japp and Edgar J. Wilcock. "On the Action of Benzoic Acid on Napthaquinon (Preliminary notice)," Dr. Japp and N. H. J. Miller.
—— Royal Institution, 3. "Cuneiform Characters," Rev. W. Houghton.
FRIDAY, 4th.—Royal Institution, 8. "Elasticity," Sir William Thomson, 9.
—— Geologists' Association, 8.
—— Society of Arts, 8. "The Results of British Rule in India," Mr. J. M. Maclean.
SATURDAY, 5th.—Royal Institution, 3. "Ancient Egypt," Mr. R. S. Poole.

ERRATA.—Page 84, line 36 from top, *for* "thermic sulphocyanate" and "thermic oxalate" *read* stannic sulphocyanate and oxalate in each case.

SOLAR PHYSICS.

The following Courses of Lectures will be given by Members of the Committee on Solar Physics, appointed by the Lords of the Committee of Council on Education:—

An Introductory Lecture. By Professor STOKES, Sec. R.S. 6th April, 1881.

A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena. By Lieut.-General STRACHEY, R.E., C.S.I., F.R.S. 8th April.

Two Lectures on the Connection between Solar and Terrestrial Phenomena. By Professor BALFOUR STEWART, F.R.S. 27th and 29th April.

Six Lectures on Spectroscopy in Relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S. 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics. By Captain ABNEY, R.E., F.R.S. 25th and 27th May and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

Admission will be by Tickets, which may be obtained, as far as there is room, on application by letter to the Secretary, Science and Art Department, South Kensington, S.W.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1110.

UPON THE INVARIABLE PRODUCTION, NOT ONLY OF OZONE AND HYDROGEN PEROXIDE, BUT ALSO OF AMMONIUM NITRATE, IN THE OZONATION OF PURIFIED AIR BY MOIST PHOSPHORUS.

By Dr. A. R. LEEDS.

As the result of very numerous quantitative experiments performed two years ago, and published in the Chemical News, vol. xl., p. 70 ("Upon Ammonium Nitrite, and upon the By-products Obtained in the Ozonation of Air by Moist Phosphorus"), I gave the proofs of the statement contained in the heading of this article, and the determinations of the amounts of the three substances formed. Forthwith, under the title "Is Ozone Produced during the Atmospheric Oxidation of Phosphorus?" (Chemical News, vol. xl., p. 96), Mr. Kingzett, without waiting to disprove any of the above propositions by experiment, asserted that "*There is no known process of slow oxidation which has been established to produce ozone*," and that the gaseous body which I had obtained and experimented upon, was altogether peroxide of hydrogen. Mr. Kingzett insisted that the long series of wash-bottles and purifiers, which I had used to absorb and hold back, as far as possible, the hydrogen peroxide, did not militate at all against his assumption, for the reason that peroxide of hydrogen suspended in a vesicular condition, might pass through all the washing liquids, and constitute the only active agent in the escaping gas. How greatly Mr. Kingzett's views have altered may be seen from the fact ("Report upon the Atmospheric Oxidation of Phosphorus, &c.," *Journ. Chem. Soc.*, Dec., 1880) that the points most dwelt dwelt upon by him in this last paper are that the escaping gas contains no peroxide of hydrogen whatsoever, but consists entirely of ozone, and that "the peroxide of hydrogen formed in the process is entirely deposited in the water contained in the oxidisers; and if it cannot escape condensation in the aqueous spray and vapour of the oxidisers, it cannot be expected to escape solution in five wash-bottles."

Since the statements of Mr. Kingzett, now, are diametrically opposed to those which he made when he attacked my results in the beginning, I think it will facilitate the labours of future workers in this field, if I present a brief summary of the facts hitherto established.

When I first entered upon the study of the phenomena exhibited in the aërial oxidation of moist phosphorus (October, 1878), the first difficulty encountered arose from the unsatisfactory character of the apparatus previously employed, and the impossibility of obtaining a stream of ozonised air containing a uniform and definite percentage of ozone. These difficulties disappeared when it was ascertained that the volume of ozone produced, under given conditions, was a definite function of the temperature, and might accordingly be expressed by a curve, having its origin at 6° C., at which temperature the production was *nil*, and arriving at its maximum at 24°, from this point falling off again rapidly. The manipulation was rendered easy by the phosphorus ozonator, described along with the volume-temperature experiments (Chemical News, vol. xl., 157). These results were referred to by Mr. Kingzett in vol. xl., p. 96; and yet in his earlier experiments performed long subsequently (vol. xli., p. 98), he states that he obtained no satisfactory evidence of the production of ozone, and but little evidence of the production of peroxide of hydrogen. Later on, when working in summer weather, Mr. Kingzett obtained better results, and discovered that his previous failures had been due to his having conducted the experiments at too low temperatures.

In plotting the volume-temperature curve, the water in the jars of the ozonator was replaced by a solution of potassium bichromate and sulphuric acid of such strength that the surface of the phosphorus was kept clean without undergoing the danger of ignition from too concentrated acid and too rapid oxidation. Mr. Kingzett states that "such a method of experiment obviously precluded examination for peroxide of hydrogen in this solution in which the phosphorus was partially submerged, and explained why he found the relation of peroxide of hydrogen to ozone as 1 : 400"! The comment of Mr. Kingzett would have been only too just if I had looked, or proposed to look, in an acidified potassium bichromate bath for undecomposed hydrogen peroxide. But Mr. Kingzett, who criticised both papers at length (*loc. cit.*), must have known at that time, a year and a half ago, though apparently he has since forgotten that I did not employ such a method. The potassium bichromate bath was employed in the determination of the volume-temperature curve of the evolved ozone only, and in that investigation no attempt was made to determine the hydrogen peroxide formed. That question was taken up at great length in the subsequent paper upon "Ammonium Nitrite, and the By-products obtained in the Ozonation of Air by Moist Phosphorus." In the experiments therein detailed, and in which the determination of the hydrogen peroxide in the ozonising chambers and in the various wash-waters is expressly considered, not merely water, but water especially purified for the purpose, was employed. This and many other precautions were essential at that time, when the exact nature and extent of the sources of error were unknown. And since these sources of error are not even alluded to, nor suitable precautions to obviate them taken, by Mr. Kingzett in his paper, it will be necessary to emphasize them here.

At that time, and even now, the generation of ammonium nitrite by evaporation of water was, and is taught as, an established fact. If this were indeed the case, the ozonising chambers present the most favourable conditions for its generation, and the nitrite thus formed would give the same reaction as hydrogen peroxide or ozone when we came to titrate the water in the ozonisers with an acidified solution of potassium iodide. The elaborate experiments of Bohlig, Zabelin, and Carius, however, have shown that this is not true, and that the alleged formation of ammonium nitrite by evaporation of water in air, never takes place when adequate precautions are taken to exclude from the evaporated water the ammoniacal compounds pre-existent in the atmosphere. Fortunately, therefore, this source of error was not inherent in the experiments themselves, and it only remained to guard against it by very complete washing of the air drawn through the ozonator.

Again, Goppelsröder and Carius had shown that when ammonia is brought into contact with ozone, it is decomposed with the formation of ammonium nitrite, ammonium nitrate, and peroxide of hydrogen. It was essential, therefore, that the phosphorus should be in contact with water from which every trace of ammonia had been expelled. If this were not done, the origin of any ammonium compounds or hydrogen peroxide found among the products of the reaction, would be rendered doubtful. It was for this reason that all the water employed in my experiments, in which a determination of the hydrogen peroxide was attempted, was *aqua purissima*, that is water re-distilled until it did not give the slightest reaction for ammonia when treated with Nessler reagent.

Moreover, while the oxidation of water to hydrogen peroxide by *free* ozone had been abundantly disproved, yet there appeared to be much reason for supposing that during the aërial oxidation of moist phosphorus, a forma-

tion of hydrogen peroxide actually took place. If this were true, its origin could not be ascribed to a secondary action due to the ozone first formed, but to the same series of changes as those which led up to the oxidation of the oxygen molecule itself. The only sufficient assignable cause was the formation of nascent oxygen, or oxygen in the atomic condition, such as it must necessarily enter into during some moment of the chemical change, when a substance of uneven quantivalence like phosphorus undergoes oxidation. That oxygen in an uncombined or monatomic condition might peroxidise the water molecule, while oxygen already combined in a triatomic molecule might not, appeared to be a legitimate hypothesis. That nascent oxygen might oxidise the nitrogen molecule at the same time, and generate, in the presence of water, ammonium nitrate, I regarded likewise as a not improbable supposition. For this reason, excessive care was taken to preclude the presence of atmospheric ammoniacal or nitrous compounds, both in the air drawn through the ozonator, and also in the water brought into contact with the phosphorus in the ozonator jars.

The mental picture which was formed at that time of the sequence of phenomena to be studied, was embodied in the following four equations, the last three being imagined as contemporaneous :—

$$1.\ P_4+O_{14}=P_2O_5+P_2O_3+2O_2+O+O. \qquad 2.\ O_2+O=O_3. \qquad 3.\ HOH+O=HO-OH.$$
$$4.\ NN+2H_2O+O=NH_4NO_3.$$

The experiments performed now two years ago, and the repetition of which, though in an imperfect manner, and with the neglect of essential precautions, constitutes the substance of Mr. Kingzett's report to the Chemical Society above alluded to, were framed with a view of testing the truth or falsity of the above propositions. What these experiments actually were may be seen by inspection of the accompanying scheme of them, which, with one exception, was followed to the letter :—

1. Use of a measured amount of *aqua purissima* in the ozonator jars.

2. Complete straining and washing of the air by means of cotton-wool, *aqua purissima*, caustic soda, and sulphuric acid, both of the latter previously tested and shown to be free from nitrogen compounds.

3. Weight of the phosphorus cakes before and after the experiments.

4. Amount of ammonia in the jar-water at the close of the experiment.

5. Amount of the nitrites and nitrates, as determined by reduction.

6. Amount of nitrous acid, as determined by meta-diamido-benzol.

7. Amounts of phosphoric and phosphorous acids, and of *hydrogen peroxide in the jar-water* (ozonising chambers).

8. Estimation of ammonia, nitrates and nitrites, nitrous acid alone, phosphoric acid, phosphorous acid, and hydrogen peroxide, in the water used to wash the escaping products of ozonation.

9. Similar estimations, except of the phosphorus compounds, in the solutions used to wash the entering air.

10. Measurement of total volumes of air used and of ozone after its escape from the water employed in washing.

With regard to the first two heads of this scheme it is to be noted that the *proof* of the exclusion of all compounds of nitrogen from the substances entering into the reaction was essential to establishing this vital fact :—That any nitrogen compounds found among the *products* were the results of chemical changes induced in the process of ozonation itself. That this preliminary proof was of the highest importance was shown by the results of the investigation: it was found that while no ammonium nitrite was present in the water of the ozonising chambers or in the wash-water, of ammonium nitrate a considerable amount (27·39 m.grms.) was present in the first, and a determinable quantity (0·31 m.grm.) even in the latter. Until adequate experimental evidence, therefore, is adduced to the contrary, the formation of ammonium nitrate during the ozonation of purified air by moist phosphorus is to be regarded as a fact which cannot be overlooked, and one which demands an explanation in any theoretic account of the chemical phenomena involved.

Mr. Kingzett, however, does not even contemplate the possibility of the nitrogen, which is relatively the most abundant of the substances present, taking part in the reaction. To say nothing of the fact that his arrangements for washing the air were inadequate, there is no proof given that the water used by him in contact with the phosphorus was pure. If it was ordinary distilled water it certainly was not pure, but contained the very body (ammonia) which was the worst possible impurity, so far as the question at issue was concerned. Not to speak of the discovery of Goppelsröder and Carius, that ammonia is converted by ozone into hydrogen peroxide and the nitrate and nitrite of ammonia, no experiment is narrated by Mr. Kingzett in which he sought to determine whether nitrous acid was present or not in any of the liquids examined. In the entire absence of such tests his determinations of the amounts of hydrogen peroxide, &c., are correspondingly incomplete. That this is not hypercriticism is shown by the fact that the dense white fumes which are seen in the ozonising chambers were at one time attributed by Schönbein to ammonium nitrite.

By referring to the seventh head of the scheme it will be seen that the determination of hydrogen peroxide in the ozonising chambers was expressly mentioned, and as preliminary to this determination experiments were made upon the possible influence of phosphorous acid upon the titration for the peroxide, and elaborate pains were taken to prove the absence of nitrous acid in the water examined. My surprise was very great on finding, after the publication of the paper, that while the hydrogen peroxide in the wash-water and every other point in the scheme had beed determined, this particular estimation had been overlooked. For this reason, in every communication written subsequently, I have never committed myself to any statement as to the total amount of hydrogen peroxide produced, knowing that it was the sum of three quantities :—(1) That referred to under the seventh head, which remains behind in the jar-water; (2) that carried forward in a state of aërial suspension, and partly detained by the wash-water; (3) that escaping along with the ozone in the evolved gas. Mr. Kingzett has called my attention to the oversight in carrying out this important part of the general seheme, and has made some estimations of the amounts of hydrogen peroxide in the ozonising chambers. Unfortunately, from his use of an acidified solution of potassium iodide as a reagent for titrating the evolved gas, and from his having employed a fan to blow the air through the apparatus without indicating the method of measuring the air, I am unable to use his results.

In my own experiment, in which 56 litres of purified air were drawn through the ozonator, the jars containing pure water, the amount of ozone in the evolved gas was 44·47 m.grms., that of hydrogen peroxide in the jar-water 35·69 m.grms. This would give for the ratio of the ozone to the hydrogen peroxide, in this particular experiment, 1 : 0·8, or by molecules ($O_3=H_2O_2$) as 1 : 0·8.

In my earlier paper (August, 1879) the amount of ozone in the evolved gas bore to the amount of peroxide of hydrogen the ratio of 400 : 1. In these experiments it was supposed that a long series of wash-bottles was sufficient to wash out the aërially suspended hydrogen peroxide, and hence the number 400 : 1 was taken as expressing the relation between the total quantities in the gas after its escape from the ozonising chambers. No statement was made, either then or subsequently, as to the total amount of hydrogen produced (owing to my original oversight in failing to determine it in the water of the ozonising chambers), but only to the amount in the evolved gas.

Subsequently, after much more elaborate experiments (Chemical News, vol. xlii., p. 19), this assumption was found to be false, and that after passing not only through

the wash-bottles, but a length of sulphuric acid dryers so great that every trace of moisture was removed, the ratio of the ozone to the hydric peroxide in the *evolved gas* was far less than 400 : 1. In the last and best agreeing series of trials it was as 51 : 31, or 1 : 0·67. The ratio of the ozone to the water formed by the decomposition of the hydrogen peroxide with the aid of heat (at 200°) was 51 : 18, or approximately 3 : 1. This ratio was accidentally given instead of the former in stating the result of the trials (*loc. cit.*).

But it will be asked what proof is there that the neutral solution employed in titrating the current of ozone and hydrogen peroxide would indicate the ozone only and not the peroxide as well? The answer is to be found in the fact that hydrogen peroxide held in vesicular suspension will pass through neutral potassium iodide solution without causing any appreciable decomposition in the latter. This was verified in the following experiment (*Jour. Amer. Chem. Soc.*, ii., 157):—"Perfectly pure and dry oxygen was ozonised by one of the 'ozonising elements" (electrical ozonisers), and then drawn through three bulbs, the first containing a solution of neutral potassium iodide, the second water, and the third chromic acid. The latter was connected with an aspirator. As soon as the strongly ozonised oxygen came into contact with the potassium iodide, a very slow current being employed, a yellow colouration made its appearance on the surface of the solution in the first bulb, and above the surface the characteristic white cloud. On increasing the rapidity of the current this white cloud was drawn through the water and chromic acid into the aspirator, and remained for one or more hours before its absorption was complete. After drawing over 6 litres of oxygen, containing 0·194 grm. of ozone, the water was titrated, and found to have absorbed 0·31 m.grm. of peroxide of hydrogen. The chromic acid solution was unaffected, showing that the suspended hydrogen peroxide may pass through it without effecting a decomposition. The same remark applies to a neutral potassium iodide put in the place of the chromic acid. The excessively dilute hydrogen peroxide held in a state of aërial suspension was not able to decompose the neutral iodide during the course of the experiment. Of course an *acidified* solution could not be employed to absorb the peroxide, since, as above shown, its decomposition occurs under the action of oxygen alone."

The conclusion, therefore, to be drawn from the above results is, that in the ozonation of air by moist phosphorus the number of molecules of hydrogen peroxide approximates very nearly to an equality with the number which is, *pari passu*, formed of molecules of ozone. That it does not fully equal this number may possibly be connected with the production, as the third essential result of the action of nascent oxygen under the circumstances studied, of a certain amount of ammonium nitrate. And not only does this relation exist between the amounts of ozone and hydrogen peroxide *produced*, but subsists, with little alteration, after the two bodies have been passed through many wash-bottles, and have been for a considerable interval in contact with one another in the *evolved* gas.

Now that I have reviewed my own labours in this direction, I wish briefly to examine Mr. Kingzett's statements concerning them.

After incorrectly stating that I looked for hydrogen peroxide in an acidified potassium bichromate bath, Mr. Kingzett adds:—"Moreover, it is not apparent from his various communications that he subjected his gaseous product to any very special examination. He seems to have relied upon its odour and general characters rather than upon any exclusive properties, as evidence of its nature."

In the first place, with regard to the odour, Mr. Kingzett has apparently overlooked the fact that, unlike his present position, which is that the body evolved is all ozone, and contains no hydrogen peroxide, he maintained at that time the opposite,—that the gas evolved was altogether hydrogen peroxide, and contained no ozone. And the only connection in which I have brought forward the smell of ozone, as an important physical quality, was to state that attention to it might have prevented Mr. Kingzett from so positively affirming that a gas which possessed the powerful and unique smell of ozone was not ozone, but another body, viz., hydrogen peroxide, which is entirely odourless.

In the next place, Mr. Kingzett has brought forward only two tests which differ from those which I have applied. The first consisted in passing the ozonised air through turpentine, and assuming that the failure of the gas, after its passage to set free iodine in a potassium iodide solution, demonstrated that it originally contained ozone only. But until it has been shown that the hydrogen peroxide suspended in the gaseous current would not undergo absorption by the oil of turpentine as well, the proof is valueless.

That this absorption would probably take place may be inferred from the action of organic liquids in general; for when the current of ozonised gas is passed into alcohol, ether, or glycerin (*Journ. Amer. Chem. Soc.*, i., 448), the white cloud entirely disappears, and hydrogen peroxide is found in the liquid. In this respect the organic liquids strikingly differ from solution of potassium iodide, water, acidified chromates, &c., inasmuch as the latter do not arrest the suspended hydrogen peroxide.

Mr. Kingzett's second novel test consisted in heating the ozonised air to 240°, and assuming that the entire destruction of the active agent at this temperature proved that it was ozone. The information to be derived from heating the gas, under proper conditions, is perhaps the most conclusive of any that can be obtained, as to its true nature. But, as Mr. Kingzett has applied the test, he has deprived it of the very conditions essential to its value. For at 240° not only ozone, but also peroxide of hydrogen is destroyed, and there is nothing in the test, as he has applied it, to prove that the active agent was ozone only, or peroxide of hydrogen only, or a mixture of both.

Prior to this I had made use of the same test (Chemical News, xlii., 19), but in a different manner. The ozonised air, after extended washing, was completely desiccated, and then exposed to temperatures running from the ordinary up to 200°. It was shown that as the reaction for ozone diminished, with the successive increments of temperature, the quantities of water derived from the decomposition of the suspended hydrogen peroxide as regularly increased. The numbers obtained by experiment exhibited this diminution of ozone and increment of water as uniformly as was to be reasonably anticipated in view of the difficult nature of the work. The total amount of water obtained in twelve experiments was 0·0086 grm., corresponding to 0·016 grm. hydrogen peroxide: the total amount of water obtained in blank experiments continued for a much longer time than those reported, and differing from the latter only in the circumstance that the phosphorus cakes were kept submerged beneath the surface of the water in the ozonator jars, was zero. We have seen with what neglect of essential precautions Mr. Kingzett has applied this test: against my results he has to urge merely his conviction (!) that they were wrong, and that the amounts of water weighed were due to water only, and not to H_2O_2. It is hardly worth while to comment—0·016 grm. is a ponderable quantity, the reality of which is capable of experimental proof or disproof, whilst a conviction is not necessarily of any weight except in the mind of its author.

The only experiment which Mr. Kingzett has brought forward in this connection shows that he has failed to apprehend the real question at issue. He passed a rapid current of air through a solution of hydric peroxide, and inferred that the failure of the air, after its passage, to effect a noteworthy decomposition in an acidified potassium iodide solution, proved (what it did not) that no H_2O_2 could be carried forward when the H_2O_2 was in a *state of aërial suspension*. Mr. Kingzett's experiment is a repetition of a similar one of my own published previously (*Journ. Amer.*

Chem. Soc., ii., 154), but illustrates merely the well-known fact that hydrogen peroxide is a difficultly vapourisable body. Mr. Kingzett appears to think that the use of a *rapid* stream of air had some bearing upon the question, and speaks of a spray of peroxide of hydrogen. The phenomena which is under investigation cannot be studied in this manner. The state of vesicular suspension of the hydrogen peroxide is not one which, so far as we are at present aware, can be brought about by mechanical means, but is one which hydrogen peroxide assumes only when it is the immediate result of a previous chemical change. This is its condition when formed in the phosphorus ozonator, and likewise when ozone undergoes decomposition in presence of water, as when it is absorbed by a solution of potassium iodide, and is the origin of the white cloud seen under these circumstances over the surface of the latter.

The difference between the two conceptions Mr. Kingzett would have noted had he been acquainted with what is the most striking reaction which occurs during the ozonation of air by moist phosphorus. This is the permanent white cloud which fills the ozonator, and is carried forward through an extensive series of wash-bottles, and remains sometimes for hours without undergoing absorption above the surface of the water in an aspirator employed to draw air through the apparatus. This white cloud was the antozone of Schönbein, which he—and after him Meissner—laboured unsuccessfully for so many years to account for. For our knowledge of its true nature we are indebted mainly to Von Babo, and after him to Nasse and Engler, who demonstrated that the so-called antozone is merely hydrogen peroxide in a state of vesicular suspension. The stumbling-block which rendered of so little value the life-long labours of Meissner upon this question was that, starting out from the well-established fact that hydrogen peroxide is not volatile, he concluded that the clouds could not be due to this substance. As the only alternative, he and Schönbein ascribed them to a peculiar modification of oxygen, other than ozone. There is danger of our giving up ground acquired with great difficulty, and falling back into hopeless contradictions, if we do not keep clearly in mind the distinction between hydrogen peroxide in its ordinary condition, in which it is not volatile, and hydrogen peroxide as suspended at the moment of its formation, in a current of air or aqueous vapour. An atmosphere saturated with aqueous vapour is most favourable to the existence of the hydrogen peroxide in a state of vesicular suspension, but is not essential, since after complete withdrawal of the water vapour the suspended hydrogen peroxide will still be present.

Summary.

1st. Both ozone and hydrogen peroxide are produced during the ozonation of purified air by moist phosphorus, in the ratio approximately of one molecule of the latter to one of the former.

2nd. Both bodies are evolved, the suspended hydrogen peroxide passing through a series of wash-bottles without undergoing any but a slight absorption, and being present in the evolved gas in nearly the same ratio as that which it held to the ozone when originally produced.

3rd. Along with these two bodies, and as a necessary part of the same series of reactions incident originally to the setting free of nascent oxygen, a certain amount of nitrate of ammonium is invariably produced. This last is altogether detained in the water of the ozonator and of the wash-bottles.

Examination of Materials from certain Vitrified Forts in France.—M. Daubrée.—The fusion of the materials composing these forts, especially those of Creuse and Côtes du Nord, which are formed of granite, testify to a surprising skill and knowledge of the management of fire on the part of their makers.—*Comptes Rendus.*

ON THE

DETERMINATION OF BASIC CINDER AND OXIDES IN MANUFACTURED IRON.

By WILLIAM BETTEL,
Late Public Analyst for Middlesbro'.

The principal value attached to determinations of slag and oxides in defective iron is the almost absolute certainty of discovering whether to the chemical constituents of the metal or to its careless manufacture may be attributed the faults observed. When we contrast the "life" of an iron rail of fair chemical purity with "mild" steel rails of nearly the same composition, it is forcibly suggested to even the most superficial observer that the duration of a rail is proportionate to the cohesion of its metallic particles, due principally to freedom from mechanical impurities. Compare iron rails made from Swedish iron, in active use for over forty years on the Great Western line near Oxford, with rails made by Danks's or any other equally good process, both presumably of the same purity, but entirely different in mechanical value.

Engineers have ever been alive to the necessity of suitable machinery for expressing the fluid cinder from the iron as it comes from the puddling and re-heating furnaces, but how rarely is the determination of cinder asked for at the hands of the analyst. We occasionally find extremely pure irons and steels—pure at least by the result of routine analysis—which are condemned when subjected to mechanical tests. In some cases a crystalline structure of the metal, perhaps in conjunction with occlusion of H, N, or CO, may weaken the iron, but it is usually the cinder which, by breaking the lines of continuity in molecular structure of the metal, determines its fracture.

We regularly determine the ordinary chemical constituents of a manufactured iron, why not its contained oxides of manganese and iron and basic cinder, which, when present in excess, weaken the iron, and so detract from its value?

The cause of the omission seems to be that no process with the exception of Eggertz's, is suitable for technical work. Fresenius's process is, without doubt, accurate, but what process can be admitted into an industrial laboratory (where a complete analysis is required in two days or less) which, for each experiment, requires a rod of the metal and several days for the completion of the analysis.

Eggertz's bromine process, although permitting the use of iron in a fine state of division, requires the employment of cooling media—not always at hand—in order to avoid the formation of basic bromides. When we consider the stability of ferric chloride at high temperatures in presence of water and excess of alkaline chlorides, due to the formation of double salts, it naturally occurs to us that the stability of solutions of bromides of iron, &c., would be ensured at a moderately high temperature in presence of excess of alkaline bromides. Again, considering the compounds of iodine with iodide of potassium, we infer that a solution of bromine in presence of an alkaline bromide will not volatilise so rapidly when heated as if free. The precipitation of manganese as oxide and basic bromide, although by this means greatly retarded, is not entirely prevented, as shown by the amount of manganese in the insoluble residue. We must therefore, after filtration, ensure its subsequent solution by reagents capable of attacking cinder and *ignited* oxides in only a very slight degree. A determination of cinder, &c., by the following method only occupies an hour or so, and has the advantage of yielding constant results:—Five grms. of the borings are heated with a solution of 10 c.c. bromine and 35 grms. KBr in 150 c.c. water. Heat is continued until the iron is dissolved, the solution filtered through a 4" Swedish paper previously washed with HCl and boiling water), drained, and washed with a solution of SO_2 containing 5 per cent HCl. When the filtrate is practically free from iron, wash with boiling water containing ½ per cent HCl, then with

pure water, rinse into small Pt dish, evaporate to low bulk, and dissolve out silica by means of hot solution of carbonate of soda. Boil, dilute, filter, wash with hot water, then with a ½ per cent solution of HCl, finally with water. Dry, ignite, and weigh. Determine the silica in the residue in the ordinary manner. The bromine in the first filtrate may be recovered as bromide of potassium in an obvious way.

Some analysts object to the Br process on account of the vapour contaminating the air of the laboratory. To those I would recommend the following process, which has given good results in my hands:—Five grms. of the iron, rather finely divided, are dissolved in 60 c.c. clear solution of $CuCl_2$ (1 in 2), mixed with 100 c.c. saturated solution of KCl. When no particles of iron can be felt by the aid of a glass rod, add 50 c.c. of dilute HCl (1 in 20), boil, and filter through a 4" Swedish paper (previously moistened with hot HCl (1 in 3), then with saturated solution of KCl). Wash the residue on the filter with KCl solution till all the copper is removed, then with hot dilute HCl (1 in 50), finally with hot water. Separate the silica as before, ignite, and weigh. If the copper obstinately adheres to the paper, as sometimes happens, slip over the tube of the funnel a piece of india-rubber tubing with clip (or plugged with glass rod), fill up funnel with strong liquid ammonia, cover, and allow to remain for half-an-hour, then proceed with dilute acid, &c., as before.

The results of both processes agree with Fresenius's galvanic method.

Analytical Laboratory and Assay Office,
The Grove, Worcester.
February 14, 1881.

ARÄOMETRIC METHOD FOR THE ESTIMATION OF FAT IN MILK.

By Dr. F. SOXHLET,
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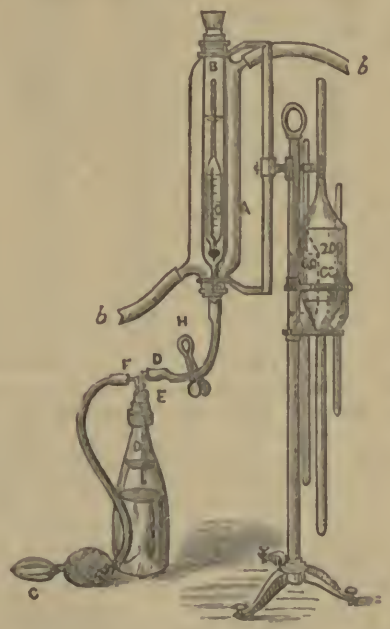
For the estimation of the most important constituent of milk, the fat, only one method has proved satisfactory, namely, the gravimetric method. The numerous methods which have been proposed to substitute circumstantial methods, and those which can only be performed by a practical chemist, are erroneous in principle, and have, therefore, little claim for accuracy. The best of those which do not claim more than relative usefulness, is that of Tollens and Schmidt (*Journal für Landwirtshchaft*, 1878, 361), which consists of an improvement of Marchand's lacto-butyrometer. However, as regards accuracy, much still remains to be desired; for, even according to the experiments made by Prof. Tollens himself, the results obtained from the same sample of warm milk differed by 0·3 per cent, and of milk after standing by 0·56 per cent, that is, a difference of 10 and 16 per cent in the amount of fat calculated to 100. In the examination of milk for the detection of adulteration, a difference of 0·3 per cent is of importance; and it is not less so in the calculations for a large dairy, as 0·3 per cent fat is equal to 10 per cent butter. Thus the problem to replace the gravimetric method by a process equally correct, and which could be used without the use of the balance, and other analytical apparatus, has not been solved by Tollens and Schmidt, and thus the examination of milk had always to be made by a chemist. The new method, which I shall now describe, is scarcely more circumstantial, or more difficult to execute, than that of Tollens and Schmidt, and gives, as will be shown, quite as satisfactory and accurate results as those obtained by the gravimetric method.

The principle of my method does not occur in any of those in use. It consists as follows:—A known quantity of milk, caustic potash solution, and ether are shaken together; the fat, as is known, dissolves completely in the ether, which, after standing for a short time, rises to the surface. A small portion of the ether, which is always constant, remains dissolved in the alkaline solution, but does not contain any fat, as the ether in the water does not dissolve the slightest trace of fat. The remaining portion of ether forms with the fat a solution whose concentration varies as the amount of fat present in the milk. The concentration of this etherial solution of fat can be ascertained by the estimation of its specific gravity with as certain and accurate results as those obtained by estimating the amount of alcohol in an aqueous solution with the alcoholometer, as the difference between the specific gravity of fat and ether is as great as between that of water and alcohol.

I pass now to the description of the process, and shall give later the foundation and explanation of the manipulations.

Apparatus and Materials.—(1.) Apparatus for the determination of specific gravities, with three pipettes for measuring the milk, caustic potash solution, and ether respectively, and several bottles in which to agitate the mixtures. (2.) Caustic potash solution, of sp. gr. 1·26 to 1·27, prepared by dissolving 400 grms. fused caustic potash in a half litre of water, which after cooling is made up to one litre; or by dissolving 400 grms. caustic potash in 870 grms.



water. (3.) Ether saturated with water. This is obtained by shaking commercial ether with one-tenth to two-tenths of its volume of water at the ordinary temperature. (4.) Commercial ether. (5.) A large vessel of at least 4 litres capacity, filled with water at a temperature of 17° to 18° C. When several estimations are to be made at the same time the vessel must be larger. When the temperature of the room is warmer, the temperature of the water should at first be 17°, when cooler 18° C.

Manner of Procedure.—The milk being thoroughly mixed, and at a temperature of 17·5° C., 200 c.c. are measured by the largest pipette and discharged into one of the bottles for agitating, which should have a capacity of 300 c.c. In the same manner 10 c.c. of the potash solution are measured, discharged into the bottle containing the milk, and mixed; 60 c.c. ether saturated with water are then added. The ether, when measured, must be between 16·5° and 18·5° C. The bottle is now closed with a cork or india-rubber stopper, shaken violently for

TABLE I.

Showing the amount of fat in weight per cent, corresponding to the sp. gr. of the etherial solution at 17·5° C.

Sp. Gr.	Fat p.c.	Sp. Gr.	Fat p.c.	Sp. Gr.	Fat p.c.	Sp. Gr.	Fat p.c.	Sp. Gr.	Fat p.c.	Sp. Gr.	Fat p.c.
43	2·07	47	2·52	51	3·00	55	3·49	59	4·03	63	4 63
43·1	2·08	47·1	2·54	51·1	3·01	55·1	3·51	59·1	4·04	63·1	4·64
43·2	2·09	47·2	2·55	51·2	3·03	55·2	3·52	59·2	4·06	63·2	4·66
43·3	2·10	47·3	2·56	51·3	3·04	55·3	3·53	59·3	4·07	63·3	4·67
43·4	2·11	47·4	2·57	51·4	3·05	55·4	3·55	59·4	4·09	63·4	4·69
43·5	2·12	47·5	2·58	51·5	3·06	55·5	3·56	59·5	4·11	63·5	4·70
43·6	2·13	47·6	2·60	51·6	3·08	55·6	3·57	59·6	4·12	63·6	4·71
43·7	2·14	47·7	2 61	51·7	3·09	55·7	3·59	59·7	4·14	63·7	4·73
43·8	2·16	47 8	2·62	51·8	3·10	55·8	3·60	59·8	4·15	63·8	4·75
43·9	2·17	47·9	2·63	51·9	3·11	55·9	3·61	59·9	4·16	63·9	4·77
44	2·18	48	2·64	52	3·12	56	3·63	60	4·18	64	4·79
44·1	2·19	48·1	2·66	52·1	3·14	56·1	3·64	60·1	4·19	64·1	4·80
44·2	2·20	48·2	2·67	52·2	3·15	56·2	3·65	60·2	4·20	64·2	4·82
44·3	2·22	48·3	2·68	52·3	3·16	56·3	3·67	60·3	4·21	64·3	4·84
44·4	2·23	48·4	2·70	52·4	3·17	56·4	3·68	60·4	4·23	64·4	4·85
44·5	2·24	48·5	2·71	52·5	3·18	56·5	3·69	60·5	4·24	64·5	4·87
44·6	2·25	48·6	2·72	52·6	3·20	56·6	3·71	60·6	4·26	64·6	4·88
44·7	2·26	48·7	2·73	52·7	3·21	56·7	3·72	60·7	4·27	64·7	4·90
44·8	2·27	48·8	2·74	52·8	3·22	56·8	3·73	60·8	4·29	64·8	4·92
44·9	2·28	48·9	2·75	52·9	3·23	56·9	3·74	60·9	4·30	64·9	4·93
45	2·30	49	2·76	53	3·25	57	3·75	61	4·32	65	4·95
45·1	2·31	49·1	2·77	53·1	3·26	57·1	3·76	61·1	4·33	65·1	4·97
45·2	2·32	49·2	2·78	53·2	3·27	57·2	3·78	61·2	4·35	65·2	4·98
45·3	2·33	49·3	2·79	53·3	3·28	57·3	3·80	61·3	4·36	65·3	5·00
45·4	2·34	49·4	2·80	53·4	3·29	57·4	4·81	61·4	4·37	65·4	5·02
45·5	2·35	49·5	2·81	53·5	3·30	57·5	4·82	61·5	4·39	65·5	5·04
45·6	2·36	49·6	2·83	53·6	3·31	57·6	4·84	61·6	4·40	65·6	5·05
45·7	2·37	49·7	2·84	53·7	3·33	57·7	4·85	61·7	4·42	65·7	5·07
45·8	2·38	49·8	2·86	53·8	3·34	57·8	3·87	61·8	4·44	65·8	5·09
45·9	2·39	49·9	2·87	53·9	3·35	57·9	3·88	61·9	4·46	65·9	5·11
46	2·40	50	2·88	54	3·37	58	3·90	62	4·47	66	5·12
46·1	2·42	50·1	2·90	54·1	3·38	58·1	3·91	62·1	4·48		
46·2	2·43	50·2	2·91	54·2	3·39	58·2	3·92	62·2	4·50		
46 3	2·44	50·3	2·92	54·3	3·40	58·3	3·93	62·3	4·52		
46·4	2·45	50·4	2·93	54·4	3·41	58·4	3·95	62·4	4·53		
46·5	2·46	50·5	2·94	54·5	3·43	58·5	3·96	62·5	4·55		
46·6	2·47	50·6	2·96	54·6	3·45	58·6	3·98	62·6	4·56		
46·7	2·49	50·7	2·97	54·7	3·46	58·7	3·99	62·7	4·58		
46·8	2·50	50·8	2·98	54·8	3·47	58·8	4·01	62·8	4·59		
46·9	2·51	50·9	2·99	54·9	3·48	58·9	4·02	62·9	4·61		

Note.—In the above table only the figures corresponding to the 2nd, 3rd, and 4th decimal places of those of the aräometer scale are given: *e.g*, the number 43·0 is equal to the sp. gr. 0·7430.

half a minute, placed in the water at 17·5° C., and shaken every alternate half minute for a quarter of an hour. After standing a quarter of an hour longer, a clear layer of the etherial solution of fat forms in the conical part of the bottle, the collection and purification of which is accelerated by giving to the contents of the bottle a gentle circular movement. It is indifferent whether the entire solution of fat, or only a portion, has collected, if there be sufficient to cause the aräometer to float. The etherial solution must be perfectly clear. With milk containing a large amount of fat (4½ to 5 per cent) the separation takes longer than a quarter of an hour; sometimes, but exceptionally, from one to two hours. In such cases, if the vessel containing the water is large enough, it is judicious to lay the well-closed bottle in a horizontal position in the water; the way for the ascending drops is thus considerably shortened, and the collection of ether hastened. When the bottle can again be placed in an upright position, the purification may be assisted by the gentle circular movement.

In order that the following manipulations may be understood, I shall now describe the apparatus for the estimation of the specific gravity of the etherial solution.

The stand has a holder fitted with a movable screw for holding the cooling tube A, to the tubes of which (*b.b.*) are attached two short india-rubber tubes. The holder of the tube A turns on its axle, so that A can be placed in a horizontal position. In the centre of A is fastened a smaller tube, B, whose diameter must be 2 m.m. greater than that of the float of the aräometer. At the lower end of B are fastened three small pieces of glass, to prevent the aräometer from adhering to the sides, while the upper end is closed by a cork. The scale of the aräometer, C, is divided into degrees from 66 to 40, corresponding to the specific gravities from 0·766 to 0·743 at 17·5° C.; these, again, are further divided by smaller and finer lines into halves. In the float of the aräometer is fastened a small thermometer, so graduated that $\frac{1}{10}$° C. may be read off. The drawn-out end of the tube B, which passes through the cork in the bottom of A, is connected by means of an india-rubber tube to the glass tube, D, which passes through the cork, E, of the agitating bottle. The glass tube, F, to which is attached the small hand-bellows, G, also passes through the cork. The stand also holds the three pipettes for measuring the milk, caustic potash solution, and ether.

The apparatus is now used as follows:—The india-rubber tube connected to the lower tube of A is placed in the vessel containing the water at 17° to 18° C. A is now filled with water by suction at B, and closed by connecting both ends (*b b*) with a glass tube. The stopper of the agitating bottle is now replaced by the cork E, and the tube D so inserted as to dip nearly to the bottom of the clear etherial solution. The cork at the top of A and the clamp H being opened, a quantity of ether, sufficient to cause the aräometer to float, is forced by means of a gentle pressure at G into the tube B. The clamp is now closed,

and the cork inserted in B in order to prevent any evaporation of ether. After waiting from one to two minutes till compensation of temperature has taken place, the aräometer is brought as nearly as possible into the centre of the tube, and the position of the scale read off. That part of the scale is read off which coincides with the middle part of the deepest curved line on the surface of the liquid (meniscus). As the specific gravity is diminished by a higher and increased by a lower temperature, the temperature during the estimation of the specific gravity of the etherial solution must be noticed. Therefore shortly before or after ascertaining the position of the aräometer, the temperature of the liquid is obtained to within $\frac{1}{10}$° C. from the thermometer in the aräometer. If the temperature be exactly 17·5° C., the specific gravity will of course require no farther correction; in other cases, however, the specific gravity obtained by the aräometer can be easily calculated to that at the standard temperature, 17·5° C. For each degree Celsius over 17·5° C., one degree is added to, and for each degree under 17·5° C, one degree is subtracted from, the statement of the aräometer; *e.g.*, 58·9 degrees at 16·8° C., at standard temperature become 58·2; 47·6 degrees at 18·4° C., at standard temperature become 48·5. The temperature of the water in A may fluctuate between 16·5° and 18·5° C. The specific gravity of the etherial solution at 17·5° C. being found, the amount of fat in weight per cent is obtained directly from Table I.

After finishing the determination, in order to prepare the apparatus for a second, the cork of B and the clamp, H, are opened to permit the ether to flow back into the agitating bottle. B is now filled from the bottle with commercial ether, which is allowed to flow back again. The tube B, india-rubber tube, &c., are now thoroughly dried by forcing a current of air through the apparatus by means of a hand bellows, G. As the aräometer is apt to be injured by coming in contact with H, it is advisable, before forcing the air through, to turn the tubes A and C to a horizontal position.

The estimation of the specific gravity, including the preparation of the apparatus for another estimation, scarcely takes five minutes. From the description of the manner of cleaning the apparatus, it will be seen that there is little risk of the aräometer being injured, as it is never taken out of the tube B. Allowing half an hour for the mixing and separation of the etherial solution, an estimation of fat may be made in from forty to forty-five minutes; but five estimations can be made as easily in an hour, when they are carried on at the same time. The method, therefore, not only allows several estimations to be made at the same time, but is also very expeditious.

As a proof of the accuracy of the results obtained by this process, as well as the soundness of the principle on which it is based, the following control-experiments are given :—

The relation of the specific gravity of the etherial solution to the fat contained in the milk was established in the following manner. Fresh, still-warm milk was, by means of a small centrifugal machine, deprived of its cream in such a manner that a cream containing about 10 per cent fat was obtained. Some of this cream was then added to another portion of milk, in such quantity as to produce a milk containing nearly 5 per cent fat. Moreover, weighed quantities of the skim milk, obtained at the same time, were mixed with weighed quantities of fresh milk. As the amount of fat contained in the fresh and skim-milk had been carefully estimated by the gravimetric method, the exact amount in each of the different mixtures was known. The most satisfactory from this series of experiments formed the basis for the calculation of the table.

The rich milk used contained 4·95 per cent, the poor 0·20 per cent fat. The hydrometer used was compared on eight points of the scale with mixtures of alcohol and ether, whose specific gravities had been exactly determined with the piknometer to the fourth decimal place, and the ascertained values rectified according to the table of corrections.

Table II.

	Rich Milk. Grms.	Poor Milk. Grms.	Sp. Gr. of Mixture at 15° C.	Amount of Fat in Mixture in weight Per cent.	Decrease of the Amount of Fat.	Sp. Gr. of the Etherial Solution.	Decrease of the Sp. Gr.
1.	1000	—	1·0297	4·95	—	0·7650	—
2.	950	50	1·0300	4·71	0·24	0·7636	0·0014
3.	900	100	1·0303	4·48	0·23	0·7621	0·0015
4.	850	150	1·0307	4·24	0·24	0·7605	0·0016
5.	800	200	1·0311	4·01	0·23	0·7588	0·0017
6.	750	250	1·0312	3·76	0·24	0·7571	0·0017
7.	700	300	1·0315	3·53	0·23	0·7553	0·0018
8.	650	350	1·0317	3·29	0·24	0·7534	0·0019
9.	600	400	1·0320	3·05	0·24	0·7514	0·0020
10.	550	450	1·0322	2·81	0·24	0·7495	0·0019
11.	500	500	1·0327	2·58	0·23	0·7475	0·0020
12.	450	550	1·0330	2·34	0·24	0·7454	0·0021
13.	400	600	1·0332	2·10	0·24	0·7433	0·0021

Table III.

		Sp. gr. of the Milk at 15° C.	Aräometric.	Gravimetric.	Difference.
Milk of separate cows from a Munich dairy; grass-fed.	1.	1·0328	4·03	4·04	−0·01
	2.	1·0304	3·68	3·70	−0·02
	3.	1·0307	3·20	3·25	−0·05
	4.	1·0310	3·73	3·68	+0·05
	5.	1·0320	3·88	3·89	−0·01
	6.	1·0332	3·88	3·91	−0·03
	7.	1·0338	3·80	3·86	−0·06
	8.	1·0303	4·58	4·64	−0·06
	9.	1·0310	3·35	3·38	−0·03
	10.	1·0310	4·06	4·09	−0·03
	11.	1·0320	3·01	2·98	+0·03
	12.	1·0340	2·65	2·66	−0·01
	13.	1·0320	3·36	3·41	−0·05
	14.	1·0324	3·54	3·49	+0·05
	15.	1·0338	2·64	2·66	−0·02
	16.	1·0305	4·01	3·98	+0·03
Milk of the Munich Milk Company; samples of six different mixtures.	17.	1·0330	3·44	3·41	+0·03
	18.	1·0320	3·23	3·27	−0·04
	19.	1·0320	3·93	3·95	−0·02
	20.	1·0320	3·18	3·21	−0·03
	21.	1·0322	4·06	4·02	+0·04
	22.	1·0310	4·09	4·10	−0·01
Milk of single cows from a Munich dairy; fed with beer malt.	23.	1·0310	3·79	3·80	−0·01
	24.	1·0338	3·97	3·98	−0·01
	25.	1·0325	4·05	4·09	−0·04
	26.	1·0328	3·45	3·48	−0·03
	27.	1·0328	2·88	2·84	+0·04
	28.	1·0312	3·14	3·12	+0·02
	29.	1·0345	2·47	2·44	+0·03
	30.	1·0330	3·41	3·44	−0·03
	31.	1·0307	3·71	3·75	−0·04
Mixtures of rich and poor milk.	32.	1·0307	4·72	4·67	+0·05
	33.	1·0314	3·84	3·84	0·00
	34.	1·0320	3·23	3·18	+0·05
	35.	1·0330	2·81	2·78	+0·03
	36.	1·0312	3·64	3·64	0·00
No. 36 with 20 per cent water.	37.	1·0260	3·07	3·04	+0·03
Milk from Munich milk shops.	38.	1·0320	3·98	4·03	−0·05
	39.	1·0312	3·70	3·63	+0·07
	40.	1·0314	3·11	3·11	0·00
	41.	1·0322	3·53	3·53	0·00
	42.	1·0318	3·68	3·61	+0·07
	43.	1·0317	4·43	4·45	+0·02
No. 43 with 20 per cent water.	44.	1·0270	3·71	3·71	0·00
Milk of separate cows.	45.	1·0325	3·60	3·60	0·00
	46.	1·0327	3·89	3·94	−0·05
	47.	1·0320	3·63	3·60	+0·03
	48.	1·0335	3·68	3·75	−0·07
	49.	1·0320	4·36	4·32	+0·04
	50.	1·0330	3·81	3·84	−0·03
	51.	1·0320	4·24	4·21	+0·03
	52.	1·0330	4·02	3·98	+0·04

In order to test the exactness of the method, the fat of 52 samples of milk, obtained from various sources, was estimated both by the aräometric and gravimetric methods. The latter method consisted in drying a weighed quantity of milk in the water-bath with gypsum, and then extracting with ether till the weight was constant. Table III. shows the results obtained.

From this list, it appears that the greatest difference between the results obtained by both methods consists only of 0·07 per cent. As a difference of 0·05 per cent between the results obtained from two estimations of the same milk by the gravimetric process is considered satisfactory, it is justifiable to state that the aräometric method is as accurate as that of the former; at least, it can be said to give the amount of fat within 0·1 per cent. The results show, further, that the method is applicable for the examination of milk of different origin and qualities. Among the samples of milk examined were those of mixed and re-mixed milk, of milk of cows fed on grass and beer-malt, of milk obtained from various dairies, and of milk mixed with 20 per cent water. Sample No. 44, which was purposely mixed with 20 per cent water, is worthy of special attention, as an example by which the genuineness of milk may be ascertained. The amount of fat (3·7 per cent) is equal to that of genuine milk, but the specific gravity is lower. The relation between the specific gravity and the amount of fat shows, in spite of the quantity of fat, that water had been added to the milk; a fact which proves that the estimation of fat, or of any other single constituent of milk, is insufficient for testing the genuineness of it. A similar relation is also shown by sample No. 37.

Besides these experiments with cows' milk, three samples of goats' milk were also examined.

	Aräometric.	Gravimetric.	Difference.
1.	5·27	5·15	+0·12
2.	2·70	2·60	+0·10
3.	3·26	3·30	+0·04

The differences here are a little greater than those already given, owing, perhaps, to the nature of the fat of goats' milk differing from that of cows' milk.

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FROM JANUARY 20TH TO FEBRUARY 19TH, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

February 21, 1881.

SIR,—We submit to you the results of our examinations of the water supplied to the Metropolis for the month ending February 19th.

These examinations have been made under instructions from the Water Companies, the selection of samples, the methods of analysis, and the form of publication have been left entirely to us, the Companies themselves taking no part in the matter beyond bearing the expenses.

It will be seen that the regularity of our work has been somewhat interfered with by the exceptional weather through which we have passed.

The turbidity (which we have duly recorded) of many of the waters may be accounted for, at any rate in part, by unavoidable conditions consequent on the severe frost. It is not improbable that it will still be some days before the waters regain their usual condition of clearness. The suspended matter is almost entirely of the nature of clay and sand, and on the worst days did not average more than one grain per gallon.

In Table I. we have recorded the analyses in detail of samples, one taken daily between Jan. 20th and Feb. 19th. The purity of the water in respect of organic matter, has been determined by the oxygen and the combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

In Table II. is recorded the colour, together with the clearness or turbidity of each sample. Of the 157 samples collected by us between the dates mentioned above, 91 were found "*clear*," 23 were noted as "*very slightly turbid*," 31 as "*slightly turbid*," and 12 as "*turbid*."

Of the 24 samples supplied by the New River Company, 2 were noted as "very slightly turbid," the remainder being clear, bright, and efficiently filtered.

Of the 18 samples from the mains of the East London Company, 6 were noted as "very slightly turbid," and 4 as "slightly turbid." The remainder were, bright, clear, and well filtered.

Of the 25 samples from the mains of the Chelsea Water Company, 5 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 18 samples from the mains of the West Middlesex Company, 4 were noted as "slightly turbid," and 2 as "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 25 samples from the mains of the Lambeth Water Company, 1 was noted as "very slightly turbid," 7 as "slightly turbid," and 5 as "turbid." The remainder were clear, bright, and well filtered.

Of the 26 samples from the mains of the Grand Junction Company, 11 were noted as "slightly turbid," and 3 as "turbid." The remainder were clear, bright, and well filtered.

Of the 21 samples from the mains of the Southwark and Vauxhall Company, 7 were noted as "very slightly turbid," 5 as "slightly turbid," and 4 as "turbid." The remainder were clear, bright, and efficiently filtered.

If a trace of suspended matter be noticeable, we record the water as "turbid." If on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid." A water is recorded as "slightly turbid" when we consider it to come between those two extremes.

In Table III. we have recorded the quantities of free oxygen in the 155 samples.

Lastly, we are of opinion that, although many of the samples examined by us, as we have stated, were more or less turbid from finely-suspended clay and sand, nevertheless the water supplied during the past month was wholesome, of good quality, and well oxygenated.—We remain, Sir, your faithful servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, February 26, 1881.

Prof. FULLER in the Chair.

THE former resolution regarding the moneys of the Society for investment was adopted.

Dr. O. J. LODGE exhibited a hydro-mechanical apparatus illustrating the fact that conductors of electricity are opaque to light, and showed by means of a Wheatstone's photometer, which combines wo circular motions into a

harmonic one, how the plane of polarisation of a beam of light passing through a magnetic medium is rotated.

Mr. C. V. Boys exhibited his new integrating machine, which is the only one illustrative of the mathematical process of integration, and is therefore specially valuable for teaching purposes.

Mr. Shelford Bidwell read a paper on the "*Telegraphic Transmission of Pictures of Natural Objects.*" The process is explained as follows:—The positive pole of a battery is connected through a set of resistance-coils to a piece of platinum wire, and the negative pole to a plate of zinc, upon which is placed a sheet of paper moistened with a solution of potassium iodide. The negative pole of a second battery is connected through a selenium cell with the same platinum wire and the positive pole to the zinc plate. The point of the platinum wire is pressed upon the paper, and the selenium being exposed to a strong light, the variable resistance is so adjusted that the currents from the two batteries, which pass through the paper in opposite directions, exactly neutralise each other. The platinum point will now make no mark when drawn over the paper, but if the selenium is shaded its resistance is immediately increased: the current from the first battery then predominates, and the path of the platinum point across the paper is marked by a brown line, due to the liberation of iodine. The line is fainter the feebler the light is. This arrangement has been applied by Mr. Bidwell in his "Telephotograph," exhibited to the meeting. The transmitter consists of a brass cylinder mounted on a screw spindle, which carries the cylinder laterally 1-64th inch at each revolution. A pin-hole in the middle of the cylinder allows light to fall upon a selenium cell placed behind it within the hollow cylinder. The cell is connected in circuit with a battery and the line. The receiver consists of a similar metal cylinder, mounted so as to rotate synchronously with the first, and having a platinum point pressing upon a sheet of chemical paper wrapped round the cylinder. This receiver and transmitter are connected up as described above with two batteries and a set of resistance coils. The image to be transmitted is focussed upon the cylinder of the transmitter, and the resistance adjusted, and the receiving cylinder covered with sensitised paper. The two cylinders are caused to rotate synchronously, the pinhole in the course of its spiral path covering successively every point of the focussed picture. The amount of light falling upon the selenium will be proportional to the illumination of that particular spot of the projected image which is for the time being occupied by the pinhole, and the intensity of the line traced by the platinum point in the receiver will vary in the same proportion. These variations will produce a picture which, if the instrument were perfect, would be a counterpart of that projected upon the transmitter. Simple designs cut of tinfoil and projected by a line have been successfully transmitted. With selenium and paper of greater sensitiveness more perfect results might undoubtedly be obtained.

Professors Ayrton and Perry showed an experiment illustrating their plan for sending light and shade images by electricity. A selenium cell was connected in circuit with a battery and a coil of wire surrounding a tube along which a beam of light passed. A shutter having a small magnet attached was suspended in the tube like a galvanometer mirror, so that when a current traversed the coils the shutter was deflected so as to close, or partially close, the tube and shut off the beam of light. It will be understood that when a ray of light fell on the cell, and diminished the resistance, the current in the coils would increase to a degree proportional to the intensity of the ray, and thus the shutter would proportionally cut off the light in the receiver. If, now, a number of these elementary circuits were combined so as to provide a mosaic of cells to transmit the reflected image of an object, and a screen to receive the corresponding beams of light controlled by the shutters at the other end of the line, there would be a means of sending light and shade images by wire. A rapidly rotating arm, carrying a row of cells upon it, might answer for a stationary mosaic transmitter, and need fewer cells, while a Japanese mirror, having its curvature altered by electromagnets behind, might be made to act as a receiver, the "magic" images of that mirror being due to inequalities of curvature.

Prof. Ayrton agreed with Mr. Bidwell in his concusion that selenium cells of high resistance were more sensitive to light than cells of low resistance.

Dr. Coffin suggested that Mr. Bidwell should adopt other than the cylindrical forms of receiver, and move an image of the object across the pinhole.

Prof. G. C. Foster advised bringing the light always on one and the same part of the selenium cell.

CORRESPONDENCE.

PURIFICATION OF SEWAGE.

To the Editor of the Chemical News.

Sir,—In regard to Mr. Spence's patent process for the treatment of sewage referred to in my paper on "Sewage Precipitation," I wish to state that Mr. Spence does not propose, on the large scale, to distil the precipitated albumin for the purpose of producing ammonia, but intends to use it in its crude condition as a constituent of artificial manure. I consider it right to add that Mr. Spence is well pleased with the practical trials he has made with Birmingham sewage.—I am, &c.,

Wm. Wallace.

City Analysts' Laboratory,
138, Bath Street, Glasgow,
March 1, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 6, February 7, 1881.

Thermic Formation of the Pyrogenous Carbides.—M. Berthelot.—Each molecule of acetylene combined in the formation of pyrogenous carbides evolves a quantity of heat approaching that produced by the union of oxygen with hydrogen to form gaseous water.

Remarks on the Characters of the Organic Chlorinised Gases and Vapours.—M. Berthelot.—The presence of volatile chlorine compounds, like chloroform, dissolved in the blood or in organic liquids, may be shown by passing their vapour mixed with air and watery vapour through a tube heated to redness. The chlorine is partly set free and partly converted into hydrochloric acid. The gases are passed into a solution of silver nitrate, and furnish a characteristic white precipitate. The action of the electric spark and that of combustion equally decompose organic chlorinated gases, and make them capable of precipitating silver nitrate. The author, however, has observed certain causes of error in such researches, due to the presence of hydrocyanic acid and of acetylene. The presence of hydrocyanic acid frustrates, in fact, the detection of chlorine and hydrochloric acid, because silver cyanide is formed even in solutions strongly acidified with nitric acid. Acetylene also forms a precipitate of silver acetylide in neutral and even in slightly acid solutions. Silver acetylide dissolves in concentrated boiling nitric acid, and the liquid remains clear on subsequent dilution with water. In case of hydrocyanic acid the gases should

be received at first in pure water, which is then boiled for some time to expel the hydrocyanic acid. Hydrochloric acid, on the contrary, remains in the liquid, since it forms a hydrate less volatile than pure water.

Double Elliptical Refraction and the Three Systems of Fringes.—M. Crouillebois.—It is established that the inverse and reciprocal rays have a real existence independent of the quartz.

A New Apparatus intended to show the Dissociation of Ammoniacal Salts.—D. Tommasi.—The author describes an apparatus which he names the dissocioscope, and which serves to exhibit at a lecture the dissociation of the ammoniacal salts.

The Derivatives of Acroleine.—E. Grimaux aud P. Adam.—The authors give an account of meta-croleine, which they obtain by the method of Geuther and Cartmell.

Action of Hydrochloric Acid upon Aldehyd.—M. Hanriot.—A continuation of the researches of Lieben (*Comptes Rendus*, xlvi., 662).

Bulletin de la Société Chimique de Paris,
Nos. 4 and 5, Sept. 5, 1880.

Application of Dialysing Apparatus for the Extraction of Iodine from the Juices of Sea-Weed.—J. Pellieux and E. Allary.—The weeds which have yielded their juice are introduced into the Pellieux incinerator, where they burn and their ashes are melted. The juice is introduced into the Porion evaporator or into contact with the hot gases of the incinerator, and are concentrated, whilst the decomposed products are retained in this incinerator. These juices, concentrated to 32° to 40° B., are conveyed to the central refinery, where they are treated in Dubrunfaut's osmogen, and thus transformed into crystalline liquids, suitable for the extraction of iodine without the necessity for calcination. The process of osmosis should be effected in heat, when it goes on ten times more rapidly than in the cold. Some years ago a pharmacist of Brest, M. Herland, proposed, under the name of "Osmotic Treatment of Sea-weeds," the following process for the extraction of iodine with the object of completely superseding incineration. The recent weeds were steeped in lime-water in which the iodides became dissolved by diffusion. The solution was then submitted to evaporation, to obtain the iodine from the concentrated mother-liquors. This process was impracticable on the large scale, and was abandoned by its author.

The Reactions of Antimony Chloride and Carbon Disulphide.—Armand Bertrand and E. Finot.—If these bodies are brought in contact in a refrigerated flask there are formed crystals of antimony sulpho-chloride. If the reaction takes place at a gentle heat the products are, as indicated by Klein, antimony trichloride, sulphur, and carbon tetra-chloride.

Studies of the Reactions Produced between Free Oxygen and Bromated Molecules where the Carbons are United by several Bonds.—E. Demole.—Not suitable for abstraction.

Action of the Chlorides of the Sulpho-conjugated Acids upon Urea.—S. U. Elander.—If 1 mol. phenylsulphurous chloride is allowed to react upon 2 to 3 mols. of urea at the temperature of the water-bath, hydrochloric acid is evolved, and a very complex body is obtained, to which the author assigns the formula—

$$C_6H_5.SO.N_4H_5.C_2O_2 + H_2O.$$

Combination of Chloral Hydrate and Camphor.—MM. P. Cazeneuve and Imbert.—Already noticed.

Pyridic Bases.—W. Oechsner de Coninck.—An account of certain derivatives of lutidine and collidine.

Ultimate Action of Bromine upon Malonic Acid: Bromoform.—E. Bourgoin.—Not suitable for abstraction.

Sorbine and Sorbite.—C. Vincent.—In two successive operations conducted according to the directions of Pelouze, the author obtained, the first time, sorbin, the second, merely sorbite. The latter body is isomeric with dulcite and mannite, and behaves like them in contact with oxalic acid.

Russian Chemical Society.—Session Nov. 1/12, 1879.—M. Kutcheroff finds that no solid fatty acids are formed on the oxidation of cholalic acid by M. Tappeiner's process.

M. Wilm proves that the substances (lime, silica, &c.) which cause an absorption of oxygen during the calcination of chromium sesquioxide are furnished from the sides of the vessel in which the operation is carried on.

M. Kapoustine indicates a process which permits a rapid determination of the carbonic acid of the air with very sufficient exactness.

M. Potilitzine communicated two important papers which will be inserted at some length.

Reimann's Färber Zeitung,
No. 37, 1880.

Wool-dyeing is now carried on with energy in Japan, and six silk-dyers have been sent from Lyon to arrange a silk-dyeing establishment at Yeddo on European principles.

Orchil paste and liquor and cudbear are now manufactured in California.

The sumac of New Brunswick is said to be equal to the best Sicilian sorts.

No. 39, 1880.

Artificial Indigo.—The nitro-product required for the production of artificial indigo can be easily obtained from cinnamic acid, or directly by the application of a substituted benzal-chloride.

At Mülhouse ceruleine is now in almost exclusive use for greens, and methylen-blue for blues, whilst Geigy's indigo-substitute is being carefully tried for dark grounds. At the chemical school Dr. Noelting lectures on general chemistry in the first year of the course, and on the aromatic compounds, the colouring matters, dyeing, and printing in the second year, six hours weekly being devoted to each course. De la Harpe teaches physics and analytical chemistry, and Dr. O. N. Witt industrial chemistry

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MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—The Chemical Laboratory at this place still enjoys a very large attendance. Besides the Directors, Geh. Hofrath and Prof. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Oberlehrer F. Henrich, and Architect Brahm. The Assistants in the Laboratory, in the Summer Term 1880, were twelve in number, and in the Versuchsstation four. In the present term, there are twelve engaged in the Laboratory and two in the Versuchsstation. In the Summer Term 1880, there were 61 students on the books; of these 39 were from Germany, 5 from England, 4 from Switzerland, 3 from Russia, 3 from North America, 2 from Austro-Hungary, 2 from Belgium, 2 from Sweden, and 1 from France. In the present Term there are 64 students; of these, 46 are from Germany, 4 from England, 3 from Switzerland, 3 from Sweden, 2 from Austro-Hungary, 2 from Belgium, 2 from North America, 1 from Russia, and 1 from South America. During the above mentioned time, numerous scientific researches were carried on in the Laboratory and the Versuchsstation, and a great number of analyses were undertaken on behalf of Manufacture, Trade, Mining, and Agriculture.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bleaching-powder.—Mr. Kingzett writes to say that during the past week he has succeeded in making a quantity of calcic hypochlorite from a fresh sample of bleaching-powder and without any difficulty whatever, by repeating his process already published in the CHEMICAL NEWS.

Aniline Black Marking Ink.—We are anxious to procure a recipe for an aniline black for marking collars and similar goods, which would be thoroughly reliable. It should be permanent, easy of application, not destructive to linen or cotton cloth, capable of keeping good a reasonable time, and always the same in strength and effects. We have tried several makes, but, as a rule, find them variable in the above points.—G. B.

MEETINGS FOR THE WEEK.

MONDAY, 7th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Institution. General Monthly Meeting, 5.
—— Society of Arts, 8. "The Scientific Principles Involved in Electric Lighting," Professor W. G. Adams, F.R.S.
TUESDAY, 8th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Medical. Anniversary, 8.30.
WEDNESDAY, 9th.—Society of Arts, 8. (In the Theatre of the South Kensington Museum) "Ascents of Chimborazo and Cotopaxi, in 1880," Mr. Edward Whymper.
—— Geological, 8.
—— Microscopical, 8.
THURSDAY, 10th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Royal Institution, 3. "Cuneiform Characters," Rev. W. Houghton.
FRIDAY, 11th.—Royal Institution, 8. "Language and Literature of the Scottish Highlands," Prof. J. S. Blackie, 9.
—— Quekett, 8.
SATURDAY, 12th.—Royal Institution, 3. "Ancient Egypt," Mr. R. S. Poole.
—— Physical, 3. "On the Absorption Spectra of Organic Bodies," Col. Festing and Capt. Abney.

TO CORRESPONDENTS.

J. Hemingway.—Wagner's "Technology," published by Churchill; Richardson and Watts's "Chemical Technology," published by Baillière.

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A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena. By Lieut.-General STRACHEY, R.E., C.S.I., F.R.S. 8th April.

Two Lectures on the Connection between Solar and Terrestrial Phenomena. By Professor BALFOUR STEWART, F.R.S. 27th and 29th April.

Six Lectures on Spectroscopy in Relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S. 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics. By Captain ABNEY, R.E., F.R.S. 25th and 27th May and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

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The next Session commences on the 25th of April. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. KREIDEL'S Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

THE CHEMICAL NEWS.

Vol. XLIII. No. 1111.

ON A

SIMPLE AND EXPEDITIOUS METHOD OF PREPARING PYROGALLOL FOR DRY-PLATE DEVELOPMENT.*

By T. E. THORPE, F.R.S.

Pyrogallol, or pyrogallic acid, is made, as the latter name implies, by heating gallic acid: but the process as usually conducted is very uneconomical, on account of the difficulty of preventing the decomposition of the pyrogallol into metagallic acid. According to the equation—

$$\underbrace{C_7H_6O_5}_{\text{Gallic Acid.}} = \underbrace{C_6H_6O_3}_{\text{Pyrogallol.}} + \underbrace{CO_2}_{\text{Carbon Dioxide.}}$$

gallic acid should yield 80 per cent of its weight of pyrogallol, but the amount usually obtained is very much less than this; on the average not more than 30 per cent is formed. The greatest yield is given at a temperature of from 185° to 200° C. If the heat be allowed to rise to 250° the gallic acid is converted into metagallic acid, carbon dioxide, and water, thus:—

$$\underbrace{C_7H_6O_5}_{\text{Gallic Acid.}} = \underbrace{C_6H_4O_2}_{\text{Metagallic Acid.}} + \underbrace{CO_2}_{\text{Carbon Dioxide.}} + \underbrace{H_2O}_{\text{Water.}}$$

The difficulties attending the conversion of gallic acid into pyrogallol have their natural effect on the price of the latter article. Photographers may be interested, therefore, in knowing how they may be able to prepare their own pyrogallol from gallic acid by a very simple and sufficiently expeditious process.

Ten grms. (say 150 grains) of dry gallic acid and 30 c.c. (say one fluid ounce) of glycerin (preferably Price's) are placed in a two-ounce flask or wide test-tube, and heated on a sand-tray to a temperature of from 190° to 200°, so long as bubbles of carbon dioxide are seen to be formed in the liquid. The gallic acid readily dissolves, and in a very short time it is entirely converted into the theoretical quantity of pyrogallol: this fact has been verified by direct observations made in my laboratory. The brown viscous liquid, after cooling, is diluted with 1000 c.c. (say 34 ozs.) of water. A solution is thus obtained, each half-ounce of which contains rather more than one-and-a-half grains of pyrogallol, sufficient, therefore, for developing a quarter-plate according to Mr. Swan's instructions. In containing glycerin it of course resembles Mr. B. J. Edwards's solution, which has found favour with many photographers.

I have developed a number of plates (mostly Swan's) with solutions of pyrogallol procured in this way, with results in nowise different from those obtained by the use of a pure aqueous solution of crystallised pyrogallol of equal strength. The method of conversion is very easy; the only point to be attended to is the temperature, which should not be allowed to exceed 200°, otherwise the glycerin becomes very brown in colour. The thermometer should be supported in the flask or tube by a cork, perforated, of course, to allow of the escape of the carbon dioxide; and the bulb should be surrounded by the liquid, which should be shaken from time to time. The solution may, however, be very dark-coloured without sensibly staining the film, provided, of course, that the time of development be not unduly prolonged—a remark which applies equally to the ordinary method of developing by means of the crystallised acid.

As the present price of pyrogallol is about seven times that of gallic acid, the above process may be worthy of the attention of photographers who practise alkaline development.

* Read to the Photographic Society of Great Britain.

LABORATORY OBSERVATIONS.

On the Detection of Iodine in Urine.

By FREDERICK FIELD, F.R.S.

Although it would appear that a solution of an iodide is a very sensitive test for platinum (Chemical News, vol. xliii., p. 75), the converse does not hold good. A platinum salt is not a good test for iodine when the latter exists in small quantities. It would seem that there must be an *excess* of the iodide to develop the rose colour, and hence mere traces are insufficient to cause the colouration of the liquid. This has been observed by Von Cottereau (*Journ. de Chim. Med.*, xi., p. 637), who says:—"Some time ago M. Aquilina recommended the chloride of platinum as a test for iodine and the iodides, it being coloured red by them. According to the author, however, this merely holds good with the iodides—for instance, iodide of potassium—and even in this case the starch is a far more sensitive test for the liberated iodine. Even the acetate of lead is a superior test for iodine compounds to the chloride of platinum."

Platinum salts existing to the extent of one in two millions impart a distinct rose colour on the addition of excess of potassic iodide to the solution, in tubes of about 20 to 25 m.m. diameter, while platinic chloride will afford no colour if the proportion of the iodide to the water in which it is dissolved is less than one to twenty-five thousand.

The employment, then, of a platinum salt for the detection of iodine is useless, as it does not for one moment compare with starch, chloroform, benzol, or carbon disulphide. Urine known to contain iodine in the form of a potassium salt gave no colouration whatever with platinic chloride, although on the addition of starch-water a blue colour was speedily developed when the iodine was liberated, and a drop of chloroform was coloured pink when added to the liquid. Experiments in this direction led me to the investigation of the detection of iodine in urine, which has occupied the attention of many chemists, the results of whose labours are, to say the least, very conflicting. Urine doubtless interferes much with the delicacy of the starch test, a fact pointed out by Löwe (Gmelin's "Handbook of Chemistry," vol. xv., p. 97), who says:—"The blue colouration of starch either does not occur, or is less pure, in presence of tannic acid, a small quantity of gallic acid, pyrogallic acid, or urine." The urea in the urine has generally been supposed to be the substance which interferes with the reaction. Pellagio, in the *Gazzetta Chemica Italiana*, in writing on the detection of iodine in urine by electrolysis, after narrating his experiments, adds:—"These reactions are less delicate in iodised urine than in the pure solution of potassium iodide, because the urea in the urine interferes with them." Giannetti also finds that "urea destroys the colour of iodide of starch, but that urine destroys the colour of this compound more quickly than it would be destroyed by the corresponding quantity of pure urea in aqueous solution." (Watts's "Dictionary of Chemistry," 2nd Supplement, p. 674). My own observations abundantly confirm the latter statement, and lead me to suppose that it is *not* the urea but some other organic matter in the urine to which this reaction is due. Urine contains at most 2 or 3 per cent of urea, and a solution of that body at such a strength in water has but little action, while urine dissolves iodide of starch with the greatest ease. The urine, however, must be undiluted. If the iodide of starch be allowed to settle,

and the supernatant liquid filtered off, a small quantity of urine added to the solid matter on the filter, dissolves it immediately, forming a pale yellow solution. After the urine has been voided several days this solvent power is very materially diminished. In spite, however, of this interference, very minute traces of iodine may be recognised in urine if the experiment be carefully watched, and it appears to me that the test proposed by Dr. David Price, viz., nitrous acid, is the most suitable (*Jour. Chem. Soc.*, vol. iv., p. 155). A drop or two of hydrochloric acid is added to the liquid, then a small quantity of clear starch-water, and subsequently a few drops of potassium nitrite. A blue streaky cloud is produced, which vanishes on agitation, if the urine be undiluted, but sufficiently distinct at the time. My observations do not agree with those of Signor Giannetti, although they are not strictly comparable, as in one case, bromine water was employed for the detection of iodine, and in the other nitrous acid. The Italian chemist detected iodine by means of carbon disulphide, when starch-water failed to give any reaction, while, on the contrary, my experiments gave the starch reaction when the sulphur compound refused to show any indication. Several samples of urine were experimented upon, voided by patients who had been taking regularly potassic iodide for some little time. One sample showed the presence of iodine most distinctly by the employment of nitrous acid and starch, and imparted a bright pink colour to chloroform, after liberation of free iodine in the liquid. In four others the blue colour was developed by starch, but neither chloroform, benzol, nor carbon disulphide was coloured when added to the solution. In another sample iodine could not be recognised. It was present, however, for on evaporation of the urine to dryness, and subsequent incineration in a platinum crubible, the residue, after digestion with a small quantity of water, gave abundant evidence of iodine.

Under most circumstances there is scarcely a more delicate test for an iodide than palladous chloride. When urine is present, this reagent is of no avail. One drop of potassic iodide added to a litre of water (the iodide being of only moderate strength) gives a dark brown colour on addition of palladous chloride. In urine, even diluted, there is no change of colour. Still more striking is the reaction of albumen. White of egg dissolved in water coagulates palladous chloride; all the metal is precipitated, not one trace passing through the filter. When potassic iodide in small quantities is dissolved in albuminous water the precipitate is somewhat darkened in the presence of palladium, but the ordinary reaction is altogether disguised. In a moderately strong solution of pure urea there is no difficulty whatever in detecting iodine by the palladium salt.

From the above observations it would seem that neither the platinum nor palladium test can be used with any certainty for the detection of iodine in urine; that the reaction of free iodine on starch water is even more delicate than the same element on carbon disulphide, benzol, or chloroform: and that it is necessary, to prove *with certainty* the existence of iodine in the excretion, to destroy the organic matter before applying the test.

ERRATUM.—In "Laboratory Observations," CHEMICAL NEWS, vol. xliii., p. 75, line 16 from bottom, *for* "by the introduction of sulphuric acid" *read* "by the introduction of hydro-sulphuric acid."—F. F.

PROTOPLASM.—A COMPLICATED SUBSTANCE.

H. J. REINKE (*Botan. Zeitung*, 38, No. 48) has examined protoplasm obtained from *Æthalium septicum*, and discovered in it the following proximate constituents:—Plastin (an insoluble albumenoid resembling the fibrins), vitellin, myosin, pepton, peptonoid, pepsin, nuclein, lecithin, guanin, sarcin, xanthin, ammonium carbonate; paracholesterin, traces of cholesterin, Æthalium resin, a yellow pigment, glycogen, sugar (non-reductive), oleic, stearic, palmitic, and traces of butyric acids, carbonic acid, fatty glycerides, and para-cholesterides; calcium stearate, palmitate, oleate, lactate, oxalate, acetate, formiate, phosphate, carbonate, sulphate (traces), magnesium (probably phosphate), potassium phosphate, sodium chloride, iron (compound not determined), and water. Plastin can be separated by pressure from the liquid portions of protoplasm. The albumenoids collectively scarcely amount to 30 per cent of the dry substance. Hence the supposition that protoplasm consists of albumen must be abandoned, and we must cease to compare a plasma cell with a particle of white of egg.

NOTE ON THE PREPARATION OF POTASSIC HYDRIC SACCHARATE.

By THOS. BAYLEY.

PURE cane-sugar is dissolved in boiling water in a wide deep test-tube until a boiling saturated solution results. To this liquid an equal bulk of strong nitric acid is added, and the mixture warmed until the reaction commences. This is very violent, and results in the disengagement of voluminous brown fumes. After the evolution of gas has ceased, the liquid is boiled. It is then, while hot, divided into equal parts, and one half neutralised with a strong solution of caustic potash. To this the other half is added, when after a short time an abundant precipitate of acid saccharate is obtained. The salt if slightly coloured is easily purified by passing the hot solution over animal charcoal, evaporating to a small bulb, and re-crystallising

NOTE ON A REACTION OF TARTARIC ACID.

By H. J. H. FENTON, B.A., F.C.S., F.I.C.

IN the CHEMICAL NEWS, vol. xxxiii., p. 190, I published a short account of a new reaction of tartaric acid, which I proposed as a test distinguishing it from citric and other acids.

The reaction is brought about by adding to a solution of tartaric acid or alkaline tartrate, a small quantity of ferrous sulphate or chloride, followed by one or two drops of hydrogen peroxide, and finally an excess of caustic potash or soda. A beautiful violet colour is thus obtained, which in very strong solutions appears almost black. At first sight it seemed probable that this colour was due to the formation of an alkaline ferrate. This explanation, however, is not supported by later experiments. The colour, for instance, is readily destroyed by chlorine or hypochlorites in an alkaline solution, which is not the case with ferrates. Moreover, if to the violet solution ferrocyanide of potassium be added, and the liquid be slightly acidulated with dilute sulphuric or hydrochloric acid, the iron may be removed by filtration, and a colourless filtrate obtained, which at once gives the violet colour on the addition of a ferrous salt. Ferric salts produce the same effect, being probably first reduced to the ferrous state, for the solution has powerful reducing properties. Salts of silver and mercury, potassium permanganate, bichromate, &c., are at once reduced by it in the cold. Cupric salts in presence of an alkali are reduced to cuprous oxide in the cold, and to metallic copper on heating.

The solution may be evaporated to dryness *in vacuo* without losing its properties, which are evidently due to some product of the decomposition, or perhaps direct oxidation, of tartaric acid. I hope soon to succeed in isolating this substance, but at present I am unable to obtain it free from admixed tartrates.

Instead of hydrogen peroxide in the above reaction, chlorine water, sodium hypochlorite, or acidulated potassium permanganate, may be used, taking care to avoid excess, but the result is not so good as with the peroxide.

If moist ferrous tartrate, obtained by precipitating a strong solution of an alkaline tartrate with a ferrous salt in the cold, be exposed to the air for a few minutes, and a solution of caustic potash be then added, the violet colour makes its appearance, though only in small quantity. External air produces this effect in a more marked degree than the air of a room, probably owing to the action of ozone. In fact, it is possible that this might afford a rough method of detecting the presence of ozone in the atmosphere. Nitrous acid does not produce the same effect.

This reaction may also be produced by electrolysing a solution of tartaric acid, using an iron plate for the positive electrode. The liquid around this plate turns yellow, and if now a solution of caustic potash be added, the violet colour at once appears.

As a test for the identification of tartaric acid this reaction is one of easy application and of average delicacy. It is necessary, however, to avoid the presence of heavy metals, and of oxidising agents, before applying it.

ARÄOMETRIC METHOD FOR THE ESTIMATION OF FAT IN MILK.

By Dr. F. SOXHLET,

Professor in the Technical High School, and Director of the Royal Agricultural Experimental Station, Munich.

(Concluded from p. 104).

I shall now give further confirmation of the principle o the method and explanations of the manipulations.

The first supposition on which the process is based is that the specific gravity of milk-fat is constant, or only fluctuates in a very small measure. Of the correctness of this supposition, proof has been already cited by means of the control-analyses of milk. Bell (*Journal of the Royal Agricultural Society of England*, 1877) examined 117 different samples of butter-fat, and found the specific gravity of butter at 100° F. In most cases the sp. gr. lay between 0·911 and 0·913, and seldom sank below 0·910. In the 117 experiments the specific gravity was 43 times 0·912, 36 times 0·911, 23 times 0·913, 9 times 0·910, 3 times 0·9094, and 3 times 0·914, *i.e.*, 102 times (87 per cent) between 0·911 and 0·913. Now, if one calculates with the extremes found, 0·9094 and 0·9139, a difference of 0·0045 arises. What then can this difference exercise on the results obtained by the arăometer? The answer is obtained from the following experiment:—

The specific gravity of pure butter-fat was obtained according to Bell at 100° F., and found to be 0·9021; 60 grms. of this fat were melted together with 40 grms. filtered tallow. The specific gravity of this mixture was ascertained to be 0·9081, the difference between the two specific gravities being 0·004.

15 grms. of the butter fat, dissolved in 100 c.c. ether, produced a solution whose specific gravity obtained by the arăometer was 0·7556. The solution of the mixture of fat and tallow, prepared under the same conditions, had the sp. gr. 0·7551. The sp. gr. 0·7556 of an etherial solution of fat, according to the Table, is equal to milk containing 3·51 per cent fat; the sp. gr. 0·7551 to milk with 3·51 per cent. Thus two solutions of fat, equal to those obtained from two samples of milk containing the same amount of fat, but whose density represented both extremes, were examined by the arăometer, and only showed a difference of 0·06 per cent.

Estcourt (Chemical News, vol. xxxiv., p. 254) also proved that the specific gravity of butter fat is a very constant number, which he found at 208° F., to be 0·8700 and 0·8707. Kônigs (*Industrie-Blätter*, 1878, p. 455) als found that the specific gravity at 100° C. lay between 0·865 and 0·868.

Another supposition is that the same amount of ether is always dissolved by the milk, so that the quantity of ether which forms the etherial solution is always constant. The temperature and the amount of dry substances contained in the milk have an influence, as well as the quantity of water, on the solubility of the ether. The temperature can be easily regulated, so that this influence is removed by using a standard temperature. The difference of the amount of dry substances can have only a trifling influence. The greater part of the casein is precipitated by the caustic potash in the form of very fine flakes, while the fat dissolves in the ether; but casein and fat chiefly cause a change in the quantity of dry substance. The control-experiments—especially those with watered milk—show, besides, that this can have little influence on the results obtained by the arăometric method.

As regards the proportions of milk, caustic potash solution, and ether, they are by no means arbitrary. It is evident that for practical reasons the given quantities may be abandoned without changing the proportion. For the experiments already given, the following quantities were for the most part used, as suitable agitating bottles of 300 c.c. capacity could not be obtained, viz., 185 c.c. milk, 9·25 c.c. potash solution, and 55·5 c.c. ether. I endeavoured to obtain the concentration of the etherial solution as strong as possible, in order to make the error of observation in the reading of the arăometer practicably harmless. But to this endeavour a limit is placed by the etherial solution when it becomes too concentrated, not rising or rising with difficulty to the surface. If, instead of 60 c.c., only 55 c.c. ether are taken for the examination of a milk containing 4½ per cent fat, the ether solution seldom rises to the surface. The proportion of ether to the potash solution has the closest connection with the separation of the etherial solution. 2 c.c., more or less, for the same quantity of ether, have great influence on the separation of the etherial solution. Generally the less potash solution is used the more ether is taken. To find the correct proportions and the nature of the action of the mixture, several hundred experiments had to be made. If the bottle be neglected to be shaken, a gelatine-like mass forms with the ether, which shows no change after several days. The necessity of working with a concentrated solution of fat, made the employment of a comparatively large quantity of milk requisite. But this does not damage the method, as the substance for examination is neither expensive or difficult to procure in quantity; on the contrary, it is a recommendation that the method permits so much of the sample to be used. It is evident that with 200 c.c., the certainty of obtaining a correct average sample is 20 times greater than when only 10 c.c., or less, are used.

The alteration of the specific gravity was found by taking the specific gravities of 10 etherial solutions, obtained from 10 samples of milk containing various amounts of fat at 16·5°, 17·5°, and 18·5° C. The specific gravities, 0·7647 and 0·7452, showed at 16·5° C. an increase, and at 18·5°C. a decrease of 0·9° to 1 0°. This favourable ratio, which allows the correction for temperature to be made without the use of a table, was the principal reason why the amount of fat in weight per cent was not stated on the arăometer.

Commercial ether contains varying quantities of alcohol and water, and is purified by shaking with water. By this means the alcohol is removed and the ether obtained completely saturated with water. The degree of saturation, which differs at different temperatures, has trifling influence on the result. Experiments showed that ether saturated with water at 25° C. gave from 0·01 to 0·02 per cent more fat than that saturated with water at 15° C. To show the great influence which the temperature has on the ether, that measured at 25° C. gave a result 0·1 per cent higher than that measured at 15° C. On that account the temperature of the ether during measurement should not

differ more than 1° C. from 17·5° C., that is, from 16·5° to 18·5° C.

In what way the quantity and concentration of the potash solution added influenced the result, was ascertained by a special experiment. When, instead of 10 c.c., 11 c.c. potash solution of sp. gr. 1·26 to 1·27 were used, the sp. gr. of the etherial solution was found 0·3°, and the amount of fat from 0·04 to 0·06 per cent lower. When the potash solution contained 450 grms. to the litre, and had the sp. gr. 1·30, the sp. gr. of the etherial solution was found from 0·1° to 0·2° too low, that is, equal to a difference of 0·02 per cent fat. It is therefore not necessary to be very exact about the preparation and measurement of the caustic potash solution. It is more important that during the shaking of the bottle and the separating of the ether, the temperature be kept constant. How great the error can be, by departing from the instructions, the following experiments will show: 14 bottles were filled in the usual manner with fresh milk containing 3·45 per cent fat.

Solutions 1 and 2 treated in the usual manner according to the instructions, gave :—

Sp. gr. 54·6 = 3·45 per cent fat.
" 54·7 = 3·46 " "

3 and 4, which were placed in water at 15° C., shaken and allowed to stand in water at 15° C. for an hour, gave—

Sp. gr. 55·0 = 3·49 per cent fat.
" 55·1 = 3·51 " "

5 and 6, which were treated in the same manner as 3 and 4, but allowed to stand twelve hours in water at 15° C., gave—

Sp. gr. 55 = 3·49 per cent fat.
" 55 = 3·49 " "

7 and 8, which were treated in the same manner as 3 and 4, but after standing one hour were placed in water at 20° C., and kept twelve hours at this temperature, gave—

Sp. gr. 54·8 = 3·47 per cent fat.
" 54·7 = 3·46 " "

9 and 10, which were shaken, placed in water at 20° C., and kept at this temperature for an hour, gave—

Sp. gr. 54·2 = 3·39 per cent fat.
" 54·0 = 3·37 " "

11 and 12, which were treated the same as 9 and 10, but kept twelve hours in the water at 20° C. gave—

Sp. gr. 54·2 = 3·39 per cent fat.
" 54·1 = 3·38 " "

13 and 14, which were treated in the same manner as 9 and 10, but placed after one hour in water at 15° C., and kept at this temperature for twelve hours, gave—

Sp. gr. 54·5 = 3·43 per cent fat.
" 54·6 = 3·45 " "

The above experiments show that during the operation, and while the bottle is standing, the mixture must be kept at a temperature which must not differ too much from that given in the instructions. A difference of 5° C. makes an alteration in the sp. gr. of 8°, corresponding to 0·1 to 0·14 per cent fat. But it is also seen that 1° C. more or less does not make much difference. The standing of the mixture, after the separation of the etherial solution, has no influence on the result if the temperature be constant. The red colour of the mixture which is observed after long standing arises from the decomposition of the milk-sugar by the caustic potash, and has no influence on the estimation. The amount of shaking is unimportant, the same result being obtained whether the bottle be shaken ten minutes or one hour; the error of observation consists at highest of 0·04 per cent; I have, at least, never obtained a greater difference from a hundred control-experiments, which I made during the perfecting of the process.

It is of the greatest importance for the correctness of the results that the aräometer be exact, and that the scale be divided as I have described. It is also necessary that the thermometer of the aräometer, at least, for the temperatures between 16·5° and 18·5° C., be correct to 0·1° C.

Herr Johannes Greiner, Munich, makes the aräometer according to a standard one, which was carefully revised by me in ten points, and sells none which has not been compared in eight points with the standard in the laboratory of the experimental station. The complete apparatus may be obtained from the above firm.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 3rd, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time :—G. H. With, F. J. Farroll. It was announced that a ballot for the election of Fellows would be held at the next meeting of the Society (March 17). The new list of the Officers and Council proposed for the ensuing year, as announced in our last report, was read from the Chair.

The President then called on Mr. F. Hatton to read a paper "*On the Action of Bacteria on Various Gases.*"* The experiments were made to ascertain the nature of the action exerted by various germs on the life and increase of bacteria, and to observe what influence the bacteria had on the percentage composition of the gases. The bacteria were obtained by shaking fresh meat with distilled water. The aqueous extract was filtered and exposed to the air for twenty-four to thirty-six hours; it was always found to be full of bacteria. A small flask was half filled with mercury, filled up with the bacteria solution, and inverted in a mercury trough. The gas under examination was then passed up, a small glass vessel was introduced under the mouth of the flask, and the whole removed from the trough. The liquid was examined daily as to the condition of the bacteria, the sample being removed by a piece of bent glass tubing having an india-rubber joint. After about a week the gas was pumped out by means of a Sprengel and analysed. Atmospheric air was first tried. The bacteria lived well during the fifteen days of the experiment (T. 15° to 22°). A large absorption of oxygen took place, but it was not replaced by carbonic anhydride; in a second experiment (T. 25° to 26·5°), 20 per cent of oxygen disappeared, and only 17 per cent of CO_2 were formed. Pure hydrogen after fourteen days had no action on the bacteria; the gas contained 0·34 per cent CO_2, 98·94 per cent H. Pure oxygen after ten days was converted into CO_2 29·98 per cent, O 70·02 per cent. A mixture of CO 46·94 per cent, CO_2 1·27, O 1·27, N 50·51, was next tried after fourteen days; the gas contained CO_2 17·77, CO 0·55, H 7·58, CH_4 2·50, N 71·57. In all of the above cases the bacteria flourished well. Cyanogen was next tried. The solution of meat turned gradually to a thick black fluid. On the fifth day very few bacteria could be seen. From this time, however, they increased, and on the twelfth day were comparatively numerous. On the fifteenth day the gas was analysed; it contained CN 5·35, CO_2 57·59, O 2·24, N 34·79; a second experiment gave similar results. It appears, therefore, that cyanogen is fatal to bacteria as long as it exists as such, but that it soon decomposes into ammonic oxalate, &c., and that the bacteria then revive, especially in sunlight. Sulphurous anhydride was next tried; the bacteria lived during the fifteen days; the gas contained CO_2 7·87, O 0·00, N 2·13, SO_2 90·10. Similar results were obtained with nitrogen, nitrous oxide, nitric oxide, carbonic anhydride, a mixture of H and O obtained by the electrolysis of water, and coal gas; in all cases the bacteria lived well during the experi-

* This paper obtained for the author the Frankland Prize of £50 at the Institute of Chemistry.

ment. The author next experimented with a solution of urea (0·98 per cent) and phosphate of potash (0·4 per cent), sowing it with bacteria. The bacteria lived well during the fourteen days of the experiment; small quantities of gas were evolved containing 0·53 per cent CO_2, 2·64 per cent O, and 96·82 per cent N. An experiment was made with spongy iron, air, and bacteria. On the fourth day, all the bacteria had vanished; the air was analysed on the fifth day, and consisted of CO_2 0·26, O 0·00, and N 99·74 per cent. Experiments were also made with acetylen salicylic acid, strychnine (10 per cent), morphine, narcotine, and brucine; none of these substances had any effect on the bacteria. On the other hand, phenol, spongy iron, alcohol, and potassium permanganate were very destructive to these microscopic growths.

Mr. W. M. Hamlet said that these experiments confirmed some observations of his own. He had found that bacteria could exist in almost anything—in carbonic oxide, hydrogen, 1 per cent creosote, phenol, methylamin, methylic alcohol, chloroform. Moreover, Crace-Calvert had shown that they could live in strong carbolic acid. In reply to Mr. Warington the speaker said that the acetic acid fermentation went on in the presence of chloroform.

Mr. Kingzett called attention to the fact that the oxygen was completely used up when the meat infusion was placed in contact with air. He did not think the experiments represented the action of bacteria on gases or of gases on bacteria, but rather the effects of various gases on the mode and extent of ordinary putrefaction.

Dr. Frankland expressed his satisfaction with the results obtained by the author in his laborious research. He must confess that these results had surprised him not a little. The fact that bacteria, which were real organisms and could not be shielded under the term putrefaction, lived and flourished in SO_2, CO, CN, &c., seemed to him very extraordinary, and the question arose whether the germs to which infectious diseases were probably due were not similarly endowed with a power of great resistance to ordinary influences.

Mr. F. J. M. Page said that Dr. Baxter had proved that with some fever-producing liquids, their virulence was destroyed by chlorine and sulphurous acid, and that he had seen some experiments at the Brown Institution which led to the same conclusion; so it seemed that, at all events in some cases, the virulence of infective liquids was due to organic matter, essentially different from the bacteria observed by Mr. Hatton.

Mr. Hatton then read a second communication "*On the Influence of Intermittent Filtration through Sand and Spongy Iron on Animal and Vegetable Matters Dissolved in Water, and the Reduction of Nitrates by Sewage, &c.*" Filtration through sand:—A 14-ft. vertical glass tube, 3¼ ins. in diameter, was filled with sand. The water was passed through at the rate of 4 litres per day. Experiments were first made with peaty water diluted with its own volume of distilled water. The organic carbon decreased 1·527 parts per 100,000, whereas the organic nitrogen was but little affected. The addition of a nitrifying material, in the shape of 5 c.c. of stale urine added to 4 litres of water, did not promote the oxidation of the organic nitrogen of the peat during filtration. A filtered infusion of rape cake was substituted for the peaty water and similar results were obtained. Some experiments are then given as to the effect of sewage in promoting the reduction of nitrates. A 5 per cent solution of clear fresh sewage containing no nitrates was added to a solution containing 0·0853 grm. of nitre. The mixture was shaken in a large stoppered bottle, and estimations of the nitric nitrogen made from time to time. For a time the nitric nitrogen steadily diminished, until, in fact, the sewage itself began to nitrify, and then the amount increased. At low temperatures the sewage does not seem to nitrify. It was found that when a solution containing nitrates and sewage was allowed to stand in contact with air, the oxygen in the dissolved air increased 4·5 per cent, while that in the air above the liquid decreased 5 per cent. In sixteen days the N as nitrates and nitrites decreased from 0·406 part per 100,000 to 0·075. Thick sewage was much more active than clear sewage. Spongy iron, when shaken up with a solution of nitre, converts the nitrogen into ammonia and free nitrogen. Filtration through spongy iron rapidly reduces the nitric nitrogen, converting it for the most part into ammonia. Filtration of peat solution and solution of egg albumen through spongy iron rapidly removed both the organic nitrogen and organic carbon, no nitric nitrogen being formed, all the nitrogen being reduced to ammonia. In some cases the carbon seemed to give rise to some marsh-gas.

Prof. Tidy then read a paper on "*River Water.*" In a previous paper the author discussed the action of the three principal agents to which the self purification of running water is due—subsidence, the scavengering propensities of fish, and the oxidation of the organic matter, this oxidation being effected partly by the oxygen in the atmosphere, and partly by the oxygen liberated by plant life. The present communication is a reply to the criticisms of Dr. Frankland on the former paper, and to a paper by Miss Halcrow and Dr. Frankland on the oxidation of peat. First as to the oxidation of peat. Notwithstanding Dr. Frankland's objections, the author still maintains that the Shannon is admirably adapted to prove oxidation, should such a process be going on. Admit the ever recurring entrance of feeders of peaty water, if it can be shown that in spite of this constant addition of peaty matter there is a manifest lessening of the peat in the water, then the experiment, considering that all the chances and conditions are against proving oxidation, becomes a hundredfold more conclusive than it would otherwise be. Admitting that at four points along a course of forty miles, at Portumna, Killaloe, O'Briensbridge, and at the junction of the Mulcaire, the organic elements do indicate a fairly uniform quantity of peat in the water, the question remains, what has become of the floods of peaty matter which have entered the river during its forty mile flow? Why does not the peat in the river increase in quantity yard by yard? Starting with a brown water at Killaloe the river should be black over and over again before it reaches Limerick. The author sums up this part of his paper thus:—I cannot question for a moment that peat is got rid of in the course of the flow of a river, and that oxidation is one of the agencies concerned in its accomplishment. He then criticises the paper by Miss Halcrow and Dr. Frankland on "The Action of Air on Peaty Water," and objects that in no sense are these experiments in which the same dribble of water is brought ever and anon into contact with the same few bubbles of air, comparable to the case of the Shannon—a river of great volume—in free and open contact with an ever-changing sea of air—luxuriant with vegetable life and fish. In one series of experiments, in which some peaty water was allowed to remain for a year in contact with some air in a stoppered bottle, the author objects that, admitting oxidation to have occurred at the layer where actual contact took place between the water and air, any carbonic acid formed would act as a party wall to divide the water from the purer air above, and, making all allowances for diffusion, there practically would be an end of the process. He also points out that the carbonic acid was in enormous excess in the air above the water, viz., 14·7 parts in 10,000. In passing, the author criticises Dr. Mills's remarks, and maintains that though the combustion and the oxygen processes both give valuable results the latter is the better of the two. In the second part of the paper the author discusses the oxidation of sewage matter by running water, and contends that if sewage be discharged into a river so that the pure water is twenty times the volume of the sewage, after a moderately rapid flow of a few miles, the whole of the impurities will, by oxidation and other agencies, disappear, and the water be again restored to its original state of purity. He objects to the opinion of the late Sir Benjamin Brodie on the point in question, as he was a witness who had

not made a single experiment bearing on this subject; he then quotes many other opinions favourable to his views, and points out that the Commission of 1850 and 1869, and the Select Committee of 1867, approved of the Thames, notwithstanding the sewage, as a source of water supply. Dr. Frankland's experiments on the Irwell, the Mersey, and the Darwen are next considered. These are, says the author, notoriously polluted sewage rivers containing no vegetation, devoid of fish, and everything was against the regaining of purity, yet Dr. Frankland's results show in the case of the Darwen a decrease of organic elements of 41 per cent, and in the Irwell of 31 per cent. Again, in the case of the Tees, a river polluted at Barnard Castle by sewage and refuse from dyers and fellmongers, after a flow of 16 miles, this river is reported at Darlington by Dr. Frankland as of unimpeachable quality, bright, and palatable. As to Dr. Frankland's statements that in the Severn a flow of 30 yards reduces the organic elements by 32 per cent, and that after a flow of a mile they were only reduced 12 per cent more, the author contends that sewage is not of a constant composition, and that some constituents are much more easily oxidised than others. As regards the wonderful diminution of chlorine remarked by Dr. Frankland, the author still maintains that it was taken up by vegetation, and quotes an experiment in which he watered some watercress with a solution containing 40 grains of salt per gallon, and increased the quantity of chlorides by 220 per cent. With respect to Dr. Frankland's criticism on the experiments with sewage in troughs, the author states that the sewage used was filtered. To the criticisms of Profs. Tyndall and Huxley, the author replies by quoting the statistics of ten years, which prove that zymotic diseases do not necessarily result (sewage or no sewage) from drinking river water, any more than they can be kept away by drinking chalk water. He asks Prof. Huxley this question—Can he give one single well-authenticated case where a drinking-water in which the chemist failed to detect manifest contamination has caused disease? The author concludes by asking Dr. Frankland—As the dangerous element in a water is entirely outside his ken or detection, what in his judgment is the good of water analysis? Seeing that 100,000 bacteria may be present in a gallon of water, each bacterium being capable of imparting disease, and yet be undetected by the most refined chemical processes, How can he report any water to be wholesome? What are his grounds for reporting a water containing 0·1 of organic carbon to be of good quality, and a water containing 0·4 of organic carbon to be of inferior quality, seeing that the first made contain millions of bacteria, which may be entirely absent from the second? Why should absolute immunity from epidemics of cholera be promised if only London would drink chalk-water, which after all is merely rain-water, and must have fallen in certain parts on heavily manured land, and has afterwards filtered naturally through chalk, and yet it be stated that there is not a tittle of trustworthy evidence to prove that artificial filtration (which, judging from analyses, is more complete than natural filtration) affords any safeguard against the propagation of epidemic diseases.

The President said that the Fellows had just listened to a powerful and interesting paper, which was sure to lead to a lively discussion. As it was very late he hoped the discussion would be strictly confined to the question of oxidation.

Mr. Hawksley had listened to the papers with much interest; much learning had been displayed, and many ingenious and elegant phrases had been used, but he did not think that anything like a solution of the process of purification as it existed in nature had been arrived at. As a practical man he would say, What does nature teach us? If we go to a mountain covered with peat we see inky water on the surface, and yet a very few feet below springs of water rise perfectly colourless and bright. This is nature, not chemistry. Similarly a stream may receive the sewage of towns, and run into the ocean without any colour at all. Moreover, the sewage of millions of inhabitants had been running into the ocean for years, and yet it remained to all appearance free from sewage. On the surface of the ocean one might well say, "Water, water, everywhere, and not a drop to stink."

Dr. Frankland said that it would be difficult to notice at that late hour all the salient points of Prof. Tidy's elaborate paper, but he would endeavour to refer to some of them. Prof. Tidy has explained that the purification of rivers is effected by three processes—subsidence, the action of fish life, and oxidation. As regards the second, he does not clearly state whether the fish remove organic matters in suspension or in solution. Fishes by respiration must clearly remove oxygen from the water, so it would seem that they could only remove organic matter in suspension; however, the substantial difference of opinion was on the question of oxidation, to which he would therefore confine his remarks. He would have liked to have said something about the admirable paper by Mr. Hatton, but as time pressed he must leave the results to speak for themselves. First, as to the oxidation of peat in the Shannon, Prof. Tidy states that in a flow of one mile from Killaloe the organic carbon decreases from 0·8 to 0·48. This really means that half of the total organic matter has been converted into carbonic anhydride, water, and nitrogen or ammonia in the flow of one mile. He would ask any chemist who has been accustomed to organic compounds whether he is acquainted with any substance which behaves in this way? To take one instance: aldehyd, a substance most prone to decomposition, under similar circumstances, would hardly be oxidised perceptibly. How improbable is it that the flow of a mile should cause such an enormous reduction, whilst the exposure of 51 square miles of surface in the loch above should have such a slight influence! Does Prof. Tidy really think that this entrance of feeders of peaty water has any very great influence on the composition of the Shannon, a river which drains about a quarter of Ireland? None of these feeders have a flow of more than a mile, and so they cannot be insignificant. He must take exception to two of the three new analyses which Prof. Tidy gives, namely, those taken one mile below Castle Connell and at Limerick: because the entrance of the largest tributary, the Mulcaire,—a river containing but little organic carbon and much suspended mineral matter (which in its deposition carries with it much organic matter),—completely prevents any fair comparison between these two places. Prof. Tidy had somewhat ridiculed the experiments which he had carried out with Miss Halcrow, on the oxidation of peaty water by agitation in a bottle with air; and Prof. Tidy, moreover, made the extraordinary statement "that, admitting oxidation to have occurred, any carbonic acid formed would probably act as a party wall to divide the water from the purer air above." Now any scientist who can accomplish such a conception without any great effort of the imagination can accomplish anything if he wishes it. This notion of a gas playing the part of a party wall need not be further alluded to. The percentage of CO_2 in the air above the peaty water, 14·7 parts in 10,000, which Prof. Tidy calls an enormous excess, is readily accounted for, as the air in the laboratory contained 9 parts, and the gases dissolved in the peaty water 199 parts in 10,000. Notwithstanding Prof. Tidy's great faith in Nature, and his objection to any experiments in a bottle, the speaker ventured to say that in the case of the bottle which was fastened to the connecting-rod of the steam-engine, the water was brought into contact with air much more perfectly than in Nature, and yet no oxidation could be detected. If the permanganate process detects volatile organic matter which is missed by the combustion process why does Prof. Tidy not prove his point by estimating the oxygen required by a water before and after boiling. He must protest against the ignorance which was ascribed to Sir Benjamin Brodie: few people had more opportunity of studying the action of oxygen on organic bodies, and he was justified by this experience in stating that it was absurd to

say that organic matter could be oxidised by rivers in such an easy way, although he had not made any experiments directly with river water. Prof. Tidy omitted to state, with regard to the supposed decrease of 41 per cent of organic elements in the Darwen, that between these two points its volume had doubled, and that when a correction was made for this observed increase in volume the 41 per cent became 13·2 per cent, and occurred in the organic nitrogen, and no decrease was observed with the organic carbon. The Thames was recommended as fit for drinking purposes by the Commission of 1869, only if the sewage was diverted and the water efficiently filtered. As to the oxidation in the Severn, where a flow of 30 yards diminished the carbon by 32 per cent,—the time taken to flow 30 yards could not be more than a minute,—"if," said Dr. Frankland, "I believed that some substance in the sewage oxidised at this rate, I would endeavour to isolate it and bring it before this Society; it would undoubtedly burst into flame when exposed to the air." Then we are asked to believe that in one minute the plant-life reduces the chlorine by 40 per cent in this section of the river. The two circumstances taken together, the diminution of the organic carbon and the chlorine, point irresistibly to dilution. In reply to Prof. Tidy's questions, he would say that water analysis tells us whether water has been contaminated with sewage, and if so, when; that a water is reported as wholesome and fit to drink when it has been filtered exhaustively through a thousand feet of porous material: on this point he should like to ask Prof. Tidy how he can report a water as turbid and yet as perfectly wholesome. If a river water contains 0·4 of organic carbon it has a disagreeable peaty taste. In conclusion he hoped that Prof. Tidy would, after reading Mr. Hatton's paper, change his opinions, and no longer believe in the utter destruction of bacteria by a cold bath in the Thames; when they withstood the action of cyanogen and sulphurous acid, it was difficult to see why they should commit suicide by bursting their envelopes by endosmosis.

Dr. Gilbert, whose remarks were received with hearty approbation, wished to raise a protest against the tendency of Prof. Tidy's paper; it, whether intentionally or not intentionally, virtually advocated the discharge of raw sewage into a river, the water of which was to be used afterwards for drinking purposes. Now there is no doubt whatever that sewage after passing over land is immensely purified, the organisms are got rid of, and the ammonia is oxidised; and it would be a great misfortune, now that much was done in this direction, after twenty years' hard work, if it should be understood by the public outside this room that the Fellows of the Chemical Society at all advocated the discharge of raw sewage into a river.

The President said that all must echo the remarks of Dr. Gilbert; they were most opportune. It seemed that there were two distinct questions. There was no doubt that the peaty matter in a river does disappear, but the oxidation of germs or bacteria was another question. Had Prof. Tidy any proof that these organisms were oxidised?

Dr. Bischoff asked Prof. Tidy whether his statistics included any year when there was an epidemic disease. As to the effect of spongy iron on bacteria he would refer the Fellows to a paper on the state of Shoeburyness, in the *Lancet* of December 25th.

Mr. Kingzett said that oxidation in Nature was probably not direct, but was effected by the infusoria, bacteria, &c.

Prof. Tidy very briefly replied. He disclaimed all intention of ridiculing Dr. Frankland's experiments, or of imputing ignorance to Sir Benjamin Brodie. He quite agreed with Dr. Gilbert's remarks; it was a very serious matter to introduce raw sewage into a river. He should always prefer deep-well water; he was emphatically a water purist. He had not the least doubt that sewage ought not to go into the river. He could not understand that shaking up water in a bottle was comparable to a running stream. Statistics are the best proof that organised matters are oxidised.

A paper by Dr. F. R. Japp and C. Colborne Graham "*On β-Diquinolin*," was taken as read. The quinolin employed was prepared from a mixture of aniline, nitrobenzine, glycerol, and sulphuric acid; it boiled at 229°. Equal volumes of quinolin and benzoyl-chloride were heated in sealed tubes to 240° to 250° for six hours. A crystalline product was obtained, which was boiled with strong HCl, filtered, extracted with ether, and finally precipitated with caustic soda. The base was obtained in colourless satiny laminæ, fusing at 191°, soluble in chloroform and boiling benzine. Analysis indicated the formula $C_{18}H_{12}N_2$. Its salts are diacid. A platino-chloride was prepared. The authors suggest the name *α*-diquinolin for the liquid prepared by Greville Williams.

The Society then adjourned to March 17th, when the following papers will be read:—"On the Volumes of Mixed Liquids," by F. D. Brown; "On Boron Hydride," by F. Jones; "On the Action of Aldehyds on Phenanthraquinon in presence of Ammonia," by F. R. Japp; "On the Action of Benzoic Acid on Naphthaquinon," by F. R. Japp; "On the Alleged Formation of Nitrous Acid during the Evaporation of Water," by R. Warington; "On the Absorption of Solar Rays by Atmospheric Ozone, and on the Blue Tint of the Atmosphere," by Prof. Hartley; "Note on the Sweet Principle of *Smilax glycyphylla*," by C. R. A. Wright and E. H. Rennie.

CORRESPONDENCE.

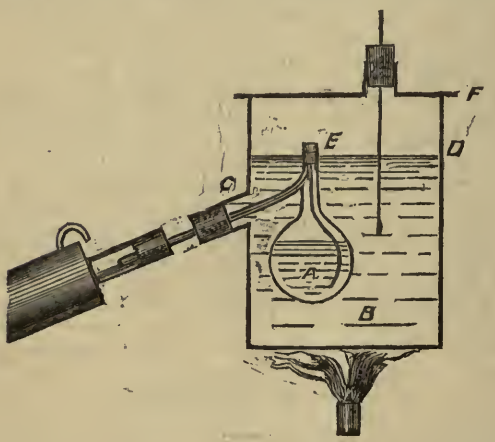
BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—I have read with interest the discussion on this subject, because I have lately had a little experience with this so-called "practical test," by which benzol is bought and sold. The instructions as to how this test is to be applied is, I understand, usually printed on the contract note, and the main points to be observed are these:—First. A retort is to be employed connected with a Liebig's condenser. Second. A thermometer is to be fitted into the retort, the bottom of the bulb of which is to be placed $\frac{5}{8}$ths of an inch from the bottom of the retort. Third. 100 c.c. of the benzol to be tested are to be placed in the retort. Fourth. Heat is to be applied by the flame of a Bunsen burner. Fifth. The distillation must be carried on so that the distillate falls rapidly in separate drops from the end of the refrigerator. Sixth. The temperature is to be allowed to rise to 100° C., the flame then taken away and the distillate measured. Similarly, the temperature is then carried to 120° C. and the distillate measured, and the measure of these distillates in cubic centimetres are supposed to give the percentages of "100° and 120° C. benzol" respectively. If any one practises for some time with the same apparatus, the same size of flame, and observe as nearly as possible the same conditions, he will, doubtless, get very nearly the same result in different experiments with the same benzol, but it is almost impossible that two persons making this test with different apparatus could get the same result. If it be considered necessary to place the bulb of the thermometer at an exact distance from the bottom of the retort, why not stipulate for the kind of thermometer to be used: there are some thermometers which have bulbs, say, $\frac{1}{4}$-inch long, and some with bulbs 1 inch long. If two such thermometers be placed at equal distances from the bottoms of the retorts, the whole of the mercury in the shorter bulb will be nearer the source of heat than in the longer bulb. Then, as to the size of flame and mode of heating, I found that I could raise the temperature above 100° C., before 20 per cent of distillate had passed over from a "50 per cent benzol," whilst the distillate fell rapidly in drops.

It is difficult to understand why such a stupid process should be adopted as a practical test, when, with less

trouble and attention to detail, a process could be used which, taking the barometric pressure into account, would give the same results in the hands of any one. The process I refer to is this :—A flask (A) with a tube passing from the neck is placed in a cylindrical copper box (B), the small tube passing through a cork fitted into a hole in the side of the box (C) passes through another cork fitted into a Liebig's condenser. The sample to be tested is placed in the flask (A) by means of a funnel with a long stem, and the mouth (E) corked by an ordinary cork or well-fitting glass stopper. The copper box is filled with water to the



point (D), and the water boiled so long as any distillate passes over. This gives the distillate at 100° C. The water may then be syphoned out of the box, a loosely fitting lid (F), with a thermometer passing through it, put on, and the copper vessel used as an air-bath, which is heated to 120° C. so long as any distillate passes over. If a process such as this were adopted, serious discrepancies in the results of different persons testing the same sample would be no longer possible.—I am, &c.,

WILLIAM THOMSON.

Manchester, Feb. 26, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Nos. 6 and 7, October 5, 1880.

Chemical Section of the Sixth Congress of Russian Naturalists and Physicians.—A. Krakau.—M. Menschutkine described the chief results obtained by M. Klimenko in his researches on the isomers of lactic acid.

M. Gustavson gave an account of his researches on the displacement of chlorine by bromine in the chlorides of carbon, and explained his theory of the reactions which take place under the influence of aluminium chloride and bromide.

M. Sabaneeff stated that the differences between the boiling-points of the analogous halogenous derivatives which correspond to ethyl hydride and ethylen are almost constant, and vary only with the nature of the halogen, independent of its quantity.

M. Andreeff exhibited his automatic apparatus for prolonged filtration.

M. Menschoutkine gave an account of the etherification of the non-saturated monobasic acids.

M. Kajander described his researches on the speed of the solution of magnesium in different acids.

M. Winogradoff gave an account of the reaction of aluminium chloride and acetyl chloride.

M. Gustavson read a preliminary communication on the action of the alcoholic bromides and C_2Br_6 in presence of aluminium bromide.

M. Hemilian announced that in causing aluminium chloride to react upon the chloride corresponding to fluorenic alcohol, dissolved in an excess of benzine or toluene, there is produced diphenylen-phenyl-methan or diphenyl-cresyl-methan. He then described the preparation and properties of diphenyl-para-xylyl-methan and diphenyl-naphthyl-methan.

M. Colley described his researches on the preparation of saccharose from glucose.

M. Beilstein gave an account of the results obtained by oxidising dinitro-α- and β-naphthalines with nitric acid.

M. Potilitzine described the action of hydrogen upon the halogen compounds of silver.

M. Beketoff exhibited the displacement of the sodium in its oxide by hydrogen, and the combination of sodium oxide with carbonic anhydride.

M. Beilstein announced that the dinitro-toluidine derived from tri-nitro-toluene is different from that obtained by the action of nitric acid upon para-toluidine.

M. Menschoutkine produced novel data on the structure of the sorbic and the hydrosorbic acids.

M. Zagoumenny has prepared tetra-phenyl-ethan by the action of nascent hydrogen upon the ether of diphenyl-carbinol dissolved in acetic acid.

M. Bogomoletz communicated the results of researches on the action of zinc-ethyl on the mono-chloro-, bi-chloro-, and tri-chloro-acetyl chlorides.

M. Wroblewsky shows that solid nitro-xylene gives on oxidation nitro-iso-phthalic acid, and that xylidine, obtained by the reduction of solid nitro-xylene, gives, on treatment with nitric acid, two nitro-xylidines.

M. Flekkel described his researches on the extraction of potash from the suint of Russian wools.

M. Konovaloff announced that the butylene obtained by the action of sulphuric acid upon iso-butylic alcohol does not form a homogeneous body.

M. Flavitzky presented a preliminary communication on a law of the variation of the specific heat of gases and vapours with the change of temperature.

M. Schœne affirmed that we possess hitherto no clear and decided proof of the existence of ozone in the atmosphere.

M. Potilitzine also expressed the opinion that ozonometric papers containing potassium iodide cannot show distinctly the presence or absence of ozone in the air, as they are affected even by carbonic acid.

M. Tchirikoff pointed out a new method of determining the hydrogen and carbon in coal.

M. Wischnegradsky explained the results of his researches on the reduction of quinoline and ethyl-pyridine.

M. Pœhl read a paper on pilocarpine.

M. Kostitcheff communicated a memoir on the combinations in which phosphoric acid is found in the soil.

M. Boutlerow made some remarks on the structure of the poly-combinations of mineral chemistry.

M. Flavitzky handed in a treatise on certain properties of the terebenthenes.

M. Danilewsky sent a memoir on the albumenoid bodies.

M. Goloubeff gave a communication on the dinitro-derivatives of desoxybenzoin.

M. Dianine finds that if phenol is mixed with chloride of lime it is chiefly converted into a trichloro-derivative.

M. Tawildaroff announced that on causing chlorine to react upon ethylidene chloride in presence of aluminium chloride there is formed exclusively trichloro-ethan.

M. Tchech described his researches on several varieties of the hop found in the south of Europe.

M. Stcherbakoff has studied the formation of a secondary alcohol under circumstances in which there have been hitherto obtained merely tertiary alcohols.

M. Ossipoff has undertaken an investigation on the re-

duction in acid solutions of the substituted fumaric and maleic acids.

M. Eltekoff explained the chief results of his researches on the phenomena of the migration of atoms.

M. Kabloukoff, in order to obtain one of the glycerins containing 6 atoms of carbon, has reduced allyl-aceton to an alcohol, and transformed the latter into an acetic ether, and by means of the latter he has prepared aceto-brom-hydrine.

M. Beletzky has investigated the decomposition of phosphorites by peat in presence of various salts.

M. Pavlevsky gave an account of an acid extracted from *Viscum album*.

Nos. 8 and 9, November 5, 1880.

Researches on Nicotine.—A. Cahours and A. Etard.—In this extensive memoir the authors give an account of thio-tetra-pyridine, its salts, its behaviour with metals, its oxidation-products, and of the bromised derivatives of nicotine.

Synthesis of Biguanide.—R. Herth.—The author, by treating sulphurea with an ammoniacal solution of copper hydroxide in the water-bath, obtains dicyano-diamide, and a secondary product, which he has transformed into a double sulphate of copper and of biguanide.

Para-gluconic Acid, an Isomer of Gluconic Acid.—M. Honig.—This acid differs from its isomers, the gluconic, dextronic, and mellitic acids, by the circumstance that its alkaline salts are crystalline, whilst those of the acids just mentioned are amorphous.

No. 10, 1880.

This number contains no original communications, but merely extracts from other journals which have been or will be noticed under their proper heads.

Journal de Pharmacie et de Chimie.
September, 1880.

Report Submitted to M. Riche to the Academy of Medicine on the Substitution of Margarine for Butter and Lard in the Public Asylums of the Department of the Seine (Conclusion).—The author finds that pure butter yields a quantity of fatty acids insoluble in water ranging from 86·5 to 88 per cent of the weight of the pure fatty matter, whilst in all the other fats and animal oils, and in almost all vegetable oils, there is from 95·20 to 95·80 per cent of insoluble fatty acids.

Solution of Chlorine in Water.—M. Berthelot.—Already noticed.

Remarks on the Saccharoses.—M. Berthelot.—The author refers to the similarity between the saccharine of Peligot and trehalose. He asks whether these approximations show really the analogy of chemical function in these two sugary matters, conformably to the ancient ideas of Laurent on hemimorphism, or do they result from some theoretic limit in the number of possible crystalline forms, or are they purely accidental? M. Berthelot also calls attention to the unequal resistance of sugars to the action of sulphuric acid. Cane-sugar and melitose are almost instantly modified by the hot acid, which is not the case with melezitose, trehalose, and sugar of milk.

Wines made from Dried Grapes (Conclusion).—M. Reboul.—Wines made from raisins are not always lævo-rotatory. This may be the case with the wines of Corinth and Thyra, but it does not hold good with the wine of Vourla, which is either optically inactive or feebly dextro-rotatory. If the alcoholic fermentation is not complete, and there remains a somewhat notable quantity of sugar, the lævo-rotatory power increases with time, or even passes from the right to the left.

A Compound of Chloral Hydrate and Camphor.—P. Cazeneuve and M. Imbert.—If solid camphor is added to solid chloral hydrate, the two bodies become totally liquefied, and give rise to a colourless syrup, which the authors regard as a true compound.

Apparatus for Producing Hydrogen Sulphide, Carbonic Acid, Hydrogen, Nitric Oxide, &c.—F. Bellamy.—This apparatus cannot be intelligibly described without the accompanying cut.

Detection and Determination of Heavy Mineral Oils, Resin Oils, Fatty Oils, and Resin in the Oils of Commerce.—A. Remont.—Already inserted (see CHEMICAL NEWS, vol. xlii., p. 39).

Specific Identity of the Inulines of the Synantheræ and of Natural Levuline.—M. Lefranc.—The author thinks it necessary to revert to the old view of the identity of the inulines from different sources.

The Spectroscope Applied to Chemical and Pharmaceutical Science (Continued).—M. Coulier.—An illustrated paper.

October, 1880.

Preparation of Chlorine.—M. Berthelot.—Already noticed.

Cinchona Barks of Java sold in Amsterdam in 1880.—G. Planchon.—The author gives a tabular view of the varieties of bark, their localities, analyses, and prices.

The Spectroscope Applied to Chemical and Pharmaceutical Science.—M. Coulier.—A continuation of a memoir which does not admit of abstraction.

Report on Scilla Maritima.—MM. Riche and Rémont.—This paper is rather of a pharmaceutical than a strictly chemical character.

Wines from Dried Grapes.—This paper is chiefly concerned with the determination of the sugar.

Hydrobromic Acid as a Reagent for Copper.—A drop of the solution in question is placed in a watch-glass, a drop of hydrobromic acid is added, and the mixture evaporated at a gentle heat. When it is reduced to the bulk of one drop a rose-red colouration appears, three or four times more intense than that produced by potassium ferrocyanide. In this manner 1-100th milligrm. copper may be detected.

Detection of Ergot in Flour.—The suspected sample is treated with cold ether or boiling alcohol to dissolve the greater part of the colouring-matters of the flour. The residue is then extracted with ether, mixed with a small quantity of sulphuric acid, and the extract is examined with the spectroscope. The ethereal extract of ergot, if concentrated, absorbs all the refrangible portion of the spectrum beyond D; if the solution is diluted, the spectrum is enlarged, and there appear three absorption-bands: the first between D and E, wave-length 538; the second between E and F, wave-length 499, and the third between F and G, wave-length 467. Hoffmann agitates the acid ethereal extract with a little solution of sodium bicarbonate, which seizes the colouring-matter of the ergot and takes a fine violet colour, whilst the colouring-matters of the flour remain in the ether.

New Characters of Guanine.—Stefano Capranica.—Characteristic reactions are obtained with picric acid, potassium chromate, and ferrocyanide.

November, 1880.

Notes on the Materia Medica of the United States.—G. Planchon.

Detection of Methylic Alcohol in Vinic Alcohol.—MM. Cazeneuve and Cotton.—The authors propose as reagent a solution of potassium permanganate containing 1-10th per cent of the dry salt. The permanganate at ordinary temperatures is reduced slowly by vinic alcohol, but instantaneously by methylic alcohol. If to 10 c.c. of vinic alcohol at 20° there is added 1 c.c. of the permanganate solution, twenty minutes are required before the liquid takes the yellow tint indicating complete reduction. If 10 c.c. of alcohol are used containing 1 c.c. of methylic

alcohol the yellow tint is instantly obtained with potassium permanganate.

Note on Officinal Sodium Arseniate.—G. Fleury

Titration of Bismuth Subnitrate.—E. Baudrimont.—This process is based upon the facts that as 0·9074 grm. of monohydrated sulphuric acid correspond to 1 grm. anhydrous nitric acid these two weights of acids will require the same quantity of alkali for exact saturation, and that bismuth subnitrate is capable of yielding all its nitric acid to an excess of alkali on boiling.

Decomposition of Salts by Liquids.—A. Ditte.—The laws of dissociation by heat, applicable to the decomposition of salts by pure water and by saline or acid solutions, apply also to decomposition by alcohols.

The Spectroscope Applied to Chemical and Pharmaceutical Science.—M. Coulier.—The continuation of a long memoir incapable of abstraction.

Reproduction of Foot-marks in Criminal Cases.—A. Jaumer has devised a method for the better comparison of foot-marks with the shoes of a suspected person. M. Hugoulin had proposed to spread powdered stearine upon the soil previously heated to 100° (? How is this to be done without disturbing the ground !), when a crust is produced which solidifies on cooling. M. Jaumer now suggests to take a plaster-cast of the stearic crust.

Biedermann's Central-Blatt für Agrikultur-Chemie, July, 1880.

[The appearance of this issue has been delayed in consequence of the death of the editor.]

Influence of the Soil upon the Tannin of Oak Bark.—Dr. M. Fleischer.—A comparison was made between the bark of young oaks grown respectively upon sandy loams, upon a peaty soil which had been once burnt, and upon a similar soil thrice burnt. The proportion of tannin was found higher in case of the peaty soils.

The Performance of Manurial Experiments.—Dr. P. Wagner and Prof. G. Drechsler.—The authors find it necessary to treat several plots of land with each manure. Each experiment should be preceeded by a blank experiment to show the natural differences between the several plots. Not one, but several unmanured portions should be left in the field. Altitude and exposure should be perfectly alike. Each plot may be 10 acres = 1190 square yards in extent. To eliminate the effects of the weather the experiments should be repeated under identical conditions for several successive years.

Manurial Experiments on Peat-Soils.—MM. Waldner and Staubesand.

A Manurial Experiment on a Peaty Meadow.—M. Kirchoff.—A mixture named "potash-magnesia"—doubtless a Stassfurt product—gave the most remunerative result, and the same product mixed with superphosphate the worst.

Influence of Manures on the Appearance of Disease and the Proportion of Starch in Potatoes.—Prof. M. Märcker.—Three plots dressed with stable manure showed 6, 6, and 5 per cent of diseased tubers. Plots where superphosphate and small quantities of ammoniacal superphosphate were used did not increase the percentage, but with larger proportions of the latter it rose to 8 per cent. Chili saltpetre was attended by a proportion of 11 per cent, and when used as a top-dressing 12 per cent.

Manurial Experiments with Sugar-Beets.—Prof. M. Märcker.—Phosphoric acid, applied preferably in the spring, increased the yield of sugar most decidedly.

Influence of Borax on the Decomposition of Albumen in the Animal Organism.—Dr. M. Gruber.—The ingestion of borax is found to increase the decomposition of albumen.

Influence of Food upon the Secretion of Milk in Cows.—Dr. W. Fleischmann.

Methods for Freeing Lupins from Bitterness.—Dr. O. Kellner.—If lupins are swelled in water, allowed to freeze and rapidly thawed, their bitterness may be entirely removed by means of cold water.

Lupin Disease of Sheep.—Prof. F. Krocker.—The disease is ascribed to a fungoid growth in the lupins.

Influence of Uninterrupted Illumination upon Plants.—Prof. Schübeler.—The author's observations refer merely to the influence of the long summer days in high latitudes where flowers, fruits, &c., gain in intensity of colour and aroma, but from the want of heat are deficient in sweetness.

Hypochlorine in Plants and its Relations to the Chlorophyll Granules.—Prof. N. Pringsheim.

Function of Vegetable Vessels.—Prof. Jos. Böhm.—These two papers are of a botanical rather than of a chemical nature.

Comparative Analyses of Normal and Sprouted Sugar-beets.—H. Pellet.

Chemical Composition of Feeding-beets.—G. Janecez.

Process for Obtaining Sugar from Beet- and Cane-Juice, Treacle, and By-Products.—Prof. K. Löwig.—A patent process for obtaining sugar by means of colloidal aluminium hydrate.

Investigations on the Sap-quotients of the Sugar-Beet.—F. Sachs.

Occurrence of Vanilla in Raw Sugars.—Dr. E. v. Lippmann and Prof. C. Scheibler.—The authors have succeeded in isolating small quantities of vanilline from crude-sugar.

Two Processes for Purifying the Waste Water of Sugar Works.—W. Knauer, C. Tœlke, Dr. Bartz, and Dr. Sickel.—Knauer, after removing froth and suspended impurities and heating to 80°, precipitates with milk of lime, runs off the effluent, and adds a little manganous chloride. Drs. Bartz and Sickel report unfavourably on this process. Tœlke reduces the consumption of water as much as possible, lets it ferment and settle, and irrigates meadows with the water.

Colouring-matter of Grapes and Bilberries and the Artificial Colouring of Red Wines.—A. Andrée.—The colouring-matters of the blue grape and of the bilberry are identical.

Colouring-Matters of Wines.—A. Gautier.—From *Comptes Rendus.*

Analysis of Certain Beers.—A. Schrader.

Purification of Alcohol with Silver Nitrate.—J. E. Berlien.—A patented process.

Difficult Fermentation of Molasses.—M. Fiedler.

Influence of the Ventilation of Must upon Alcoholic Fermentation.—E. Rotondi.—The author considers that ventilation mechanically promotes the decomposition of the sugar, and acts also chemically, because the albumenoid bodies are transformed into more diffusible matters, and because oxygen by increasing the quantity of the ferment indirectly intensifies the fermentation.

Inferior Organisms Present in the Air.—E. C. Hansen.—The microscopic beings in the air are very unequally distributed. The germs of beer-yeast are not everywhere present. Bacteria are much less common than the moulds, such as *Penicillium glaucum*, *Mucor stolonifer*, &c.

The Best Temperature for Mashing and for the Formation of Sugar.—M. Rœhr.—The author found the transformation complete at 40° R. = 122° F.

Action of Salicylic Acid.—A. Schultz.—From the *Journal für Praktische Chemie.*

Die Chemische Industrie.

No. 9, September, 1880.

Chemical Industry at the Düsseldorf Exhibition, 1880.—Jos. Horadam.—A very complete account of the chemical manufactures of Westphalia, Rhenish Prussia, &c., which, it appears, employ 2266 workmen. The tar colour manufacturers of Crefeld, Höchst, &c., were not represented.

Attempts at the Manufacture of Sodium Ferrocyanide.—S. Tinatar.—From a number of experiments in which animal charcoal was ignited with compounds of potassium and sodium, and with various reducing agents, it appears that sodium compounds are capable of yielding cyanides. Experiments with a mixture of 10 parts animal charcoal with 25 parts sodium chloride and 5 parts sodium carbonate, or 25 sodium chloride, 5 sodium carbonate, and 3 calcium carbonate, to which 10 per cent of cast-iron turnings were added, gave good results. The separation of the sodium ferrocyanide from the melt is very difficult. The author concludes that the liberation of an alkali metal is not the cause of the formation of cyanogen, as it was produced in large quantities in mixtures, where an alkaline metal could not be liberated in appreciable quantities.—*Dingler's Pol. Journ.*, 237, p. 234.

No. 10, 1881.

Besides a long address by Prof. Klostermann on the influence of the protection of inventions, designs, and trademarks, in which the speaker falls into the error of asserting that the right of the patentee is created by law, this number is filled with abstracts of patent specifications and extracts from other journals.

MISCELLANEOUS.

"How is Petroleum to be Examined?"—The author's name is J. Skalweit, not F. Skalweit as printed in our number for February 18. We are requested to state that the little petroleum proof-apparatus is to be had at Hanover, at the office of G. Schnath, 8, Markt Strasse, Hanover, for 5 shillings.

MEETINGS FOR THE WEEK.

MONDAY, 14th.—London Institution, 5.
—— Medical, 8.30.
—— Royal Geographical, 8.30.
—— Society of Arts, 8. "The Scientific Principles Involved in Electric Lighting," Professor W. G. Adams, F.R.S.

TUESDAY, 15th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Society of Arts, 8. "The Diamond Fields of South Africa," R. W. Murray.

WEDNESDAY, 16th.—Society of Arts, 8. "The Compound Air-Engine," Col. F. Beaumont, R.E.
—— Meteorological, 7.

THURSDAY, 17th.—London Institution, 7.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
—— Royal Institution, 3. "Ornament," Mr. H. H. Statham.
—— Chemical, 8. "On the Volumes of Mixed Liquids," F. D. Brown. "On Boron Hydride," F. Jones. "On the Action of Aldehydes on Phenanthraquinone in Presence of Ammonia," F. R. Japp and Edgar Wilcock. "On the Action of Benzoic Acid on Naphthaquinone," F. R. Japp and H. J. N. Miller. "On the Alleged Formation of Nitrous Acid during the Evaporation of Water," R. Warington. "On the Absorption of Solar Rays by Atmospheric Ozone, and on the Blue Tint of the Atmosphere," Prof. Hartley. "Note on the Sweet Principle of Smilax Glycyphylla," C. R. A. Wright and E. H. Rennie.

FRIDAY, 18th.—Royal Institution, 8. "Musical Pitch," Dr. W. H. Stone, 9.

SATURDAY, 19th.—Royal Institution, 3. "American Humourists," Rev. H. R. Haweis.

TO CORRESPONDENTS.

Theophilus Pitt.—No accurate process is known.

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SOLAR PHYSICS.

The following Courses of Lectures will be given by Members of the Committee on Solar Physics, appointed by the Lords of the Committee of Council on Education:—

An Introductory Lecture. By Professor STOKES, Sec. R.S. 6th April, 1881.

A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena. By Lieut.-General STRACHEY, R.E., C.S.I., F.R.S. 8th April.

Two Lectures on the Connection between Solar and Terrestrial Phenomena. By Professor BALFOUR STEWART, F.R.S. 27th and 29th April.

Six Lectures on Spectroscopy in Relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S. 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics. By Captain ABNEY, R.E., F.R.S. 25th and 27th May and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

Admission will be by Tickets, which may be obtained, as far as there is room, on application by letter to the Secretary, Science and Art Department, South Kensington, S.W.

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THE CHEMICAL NEWS.

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ON THE SOLUBILITY OF SULPHUR DIOXIDE IN SULPHURIC ACID.*

By J. T. DUNN, B.Sc.

Some time ago, I had occasion to make some experiments in which sulphur dioxide, the volume of which it was necessary to measure, was evolved in contact with strong sulphuric acid. The results were very discordant, and differed amongst themselves in a way which I could only explain by supposing that the gas had dissolved in the acid, and that varying quantities had been taken up in the different experiments.

I could not find any information on the subject in the usual books of reference, but a simple experiment showed that the solubility of SO_2 in oil of vitriol was quite appreciable. I filled a graduated tube with dry SO_2 over mercury, and with the help of a pipette passed up a small quantity of concentrated sulphuric acid. There was an immediate rise of liquid in the tube, and the absorption continued at a decreasing rate for about three days, at the end of which time the level of the liquid in the tube was tolerably constant, even after agitation. The original volume of gas (reduced to normals) was 61·5 c.c., and the residual gas after absorption 27·5 c.c., so that 34 c.c. had been absorbed by the quantity of acid used, 10 c.c. The tension of the gas at the end of the experiment was about 506 m.m., so that this very rough determination would give as the absorption coefficient of SO_2 in sulphuric acid at 14° C. and 760 m.m., about 5·1.

I was curious to know whether the coefficient determined in this rough way would be any approach to the actual solubility, because the experiments to which I have referred above rather led me to think that the amounts of gas dissolved by being simply confined in a tube over H_2SO_4 might vary within very wide limits; and I therefore proposed to myself to determine the solubility with some degree of accuracy.

The solubility not being extremely small, I determined it in the first instance directly, by the increase in weight of a known volume of H_2SO_4 when saturated with gas. The SO_2 was prepared in the usual way from copper and sulphuric acid, and was carefully dried by first bubbling through strong sulphuric acid in a washbottle, and then passing over about 2 feet of sulphuric-acid-pumice. The acid used to absorb the gas was pure re-distilled acid, having a specific gravity of 1·840 at 15° C. It was contained in a test-tube fitted with a cork which carried the entrance and exit tubes for the gas, and a thermometer; the volume of this apparatus was known. The test-tube having been weighed before and after the introduction of the sulphuric acid, the volume of the latter was calculated from its weight. SO_2 was passed through the apparatus for about three hours, the exit tube being connected with a guard tube of calcic chloride to prevent the sulphuric acid picking up moisture from the outer air, and the absorption apparatus being immersed in water to secure approximate constancy of temperature. The temperature and pressure were now observed, and the apparatus re-weighed. The space above the acid in the test-tube, which originally contained air, was at the end of the experiment of course full of SO_2, and a deduction had to be made on this account, the amount of which was easily calculated when the volume of acid and the total volume of the apparatus were known. The following are the figures obtained:—

Weight of H_2SO_4	33·1857 grms.
Volume at 15° C.	18·036 c.c.
Weight of SO_2 absorbed	1·4184 grms.
Volume at normals	494·67 c.c.
Temperature	17° C.
Barometer	742·4 m.m.
Observed coefficient of absorption	27·49
Coefficient at 760 m m.	28·14

I satisfied myself that the acid was saturated, by replacing the apparatus, and passing the gas for another hour, when no increase in thd coefficient was given.

A second similar experiment gave as the coefficient of solubility at 16 C., the figure 28·86, which agrees very well with the first.

It will be seen that the solubility determined in this way is more than five times as great as that deduced from the first rough experiment above-mentioned, and this shows that even prolonged contact of the gas with the absorbent (for after the third day, when the measurements were taken, they were left in contact in the tube for three weeks without a measurable increase in the absorption) is not in all cases sufficient to insure even an approach to saturation.

After I had made these determinations my attention was drawn to a table in Dr. Lunge's treatise on "Sulphuric Acid and Alkali," vol. i., p. 29, wherein are given the following solubility-coefficients for acids of different strengths:—

Sp. gr.	Litres of SO_2 dissolved. Per litre acid.
1·841	5·8
1·839	8·9
1·540	11·2
1·407	15·9
1·227	29·7
1·000	49·0

It is not stated whence these results are derived, by what method they were obtained, nor the temperature at which they were taken. From the figure for water, however, it is evident that the temperature must be about 15° or 16° C., and if that is the case for all the results, the figures for acids of 1·841 and 1·839 sp. gr. differ enormously from those which I have obtained for acid of 1·840. In the absence of information as to the methods employed, it is useless to speculate on the cause of such a discrepancy; but it is worthy of remark that the figures (5·8) for acid of 1·841 sp. gr. is not far removed from that (5·1) given by my trial experiment with the graduated tube.

I have made a number of determinations by another method, with the view of ascertaining the influence of temperature and strength of acid on the solubility; these are not yet complete, but as far as they have gone they have established the fact that at 84° C. the coefficient for acid of 1·840 sp. gr. has diminished to 4·5, and have confirmed the coefficients already given for temperatures about 16°.

* A paper read before the Newcastle-upon-Tyne Chemical Society, January 27, 1881.

THE ACTION OF SEA-WATER UPON CAST-IRON.*

By A. LIVERSIDGE,

Professor of Geology and Mineralogy in the University of Sydney.

The specimen forming the subject of this note was obtained from the screw of the dredge *Hunter* employed in Newcastle Harbour, New South Wales.

Mr. Moriarty, the Engineer-in-Chief for Harbours and Rivers, tells me that the dredge had not been wrecked as I had previously been informed—in fact she is still at work; but that the screw became so rotten as to necessitate its

* A Paper read before the Royal Society of New South Wales, September 1, 1880.

removal. He accounts for the rapid decay, and very sufficiently, by the iron having been in actual contact with the copper sheathing of the vessel. In the same letter Mr. Moriarty mentions that an old iron cannon was taken up from the foul waters at the head of Darling Harbour, where it had lain for some twenty years, but the corrosion had only eaten its way into about $\frac{1}{16}$ of an inch.

Even on the most cursory examination the specimen is seen to differ entirely from the original cast-iron, except in form, which seems to be unchanged; the material, however, is so altered in composition that it may be safely described as a pseudomorph, since it is almost entirely made up of oxide of iron and particles of graphite. It is quite sectile, being readily cut with a knife; the powder under the microscope presents a mixture of brilliant scales of graphite, mixed with brown-coloured oxide of iron and a few widely scattered minute particles of metallic iron; these on removal by means of a magnet answer to all the tests for metallic iron, and flatten out with a bright metallic lustre when ground in an agate mortar.

In colour the external part of the specimen is of a dull grey, within it is of a rusty brown colour, with darker bands which follow more or less closely the outer contour lines.

Different portions of the mass apparently vary somewhat in composition; the portion taken for examination was purposely chosen from the innermost part, as it appeared to be firmer and less friable that the very outside of the specimen; but even this only contained 0·04 per cent of metallic iron; the boss of the screw was, I understand, only superficially acted upon; the part examined by me came from one of the blades. On analysis it was found to have the following composition:—

Carbon	68·73
Iron protoxide	23·23
Iron sesquioxide	1·79
Iron, metallic	0·04
Manganese	0·62
Phosphorus	absent
Sulphur	traces
Silicon	5·59
	100·00

The specific gravity at 62° F. taken upon a piece weighing 58·405 grms. was found to be but 1·63.

The carbon was not estimated directly, partly on account of the difficulty of satisfactorily determining its amount by the combustion process, and partly because, after everything else had been determined, it was thought that the amount of carbon could be estimated with sufficient accuracy by taking the difference.

The silicon was estimated in the form of silica by fusion with the mixed carbonates of potash and soda, the carbon being burnt off by the addition of potassium chlorate; the residue was extracted with boiling water, the silica rendered insoluble and determined in the usual way.

The metallic iron was extracted by means of a magnet, treated with fuming nitric acid, to get rid of attached impurities, washed, dissolved in hydrochloric acid, and estimated volumetrically.

It is interesting to note that the phosphorus has been eliminated completely by the action which has gone on, and that the amount of sulphur is quite small; for both were probably present in the original cast-iron.

Several instances of the effects produced by sea-water acting upon cast-iron are quoted by Gmelin in his "Handbook of Chemistry," vol. v., p. 218. These are also referred to in Watts's "Dictionary of Chemistry," vol. iii., p. 331, but no additional cases appear to be cited in the latter work, although published in 1871, *i.e.*, twenty years later. The instances quoted are the following:—

"Certain cannon-balls out of a number which had lain for forty-two years under sea-water were found to be converted into a substance like plumbago, some to the distance of half an inch, others to the very centre."—(*Sill. Amer. Jour.*, 4, p. 178.)

"Some cannon-balls lying in the sea on the coast of Norway since 1692, had retained their form and bulk, but had lost two-thirds of their weight, yielded to the knife, did not act upon the magnet, and were free from metallic iron (Deslongchamp, J., *Chem. Med.*, 13, p. 89)."

"Cannon-balls raised at Carlscrona from a sunken vessel, lost fifty years previously, were found to be changed through one-third of their thickness into a porous graphitic mass, which became strongly heated when exposed to the air for a quarter of an hour; in fact, so hot as to drive the water off in steam."—(*Berzelius Lehrb.*)

Dr. Percy, F.R.S., lately Professor of Metallurgy at the Royal School of Mines, in his volume on the metallurgy of iron and steel, quotes some instances collected by Henry Wilkinson in his work "On the Extraordinary Effects Produced on Cast-iron by the Action of Sea-water," 1841. Amongst them he gives the following:—"Many of the vessels of the Spanish Armada were sunk off the shore of Mull in Scotland, and in 1740 some of the guns of a vessel named the 'Florida' were raised. These were both brass and cast-iron guns, and on scraping the latter, which were deeply corroded, they became so hot that they could not be touched. However, they lost this property after two or three hours exposure to the air, and there was no difference in the appearance of the substance before and after the combustion." "In a naval engagement with the French at Portsmouth in 1545, the *Mary Rose* of the English Fleet was so overweighted with ordnance that she sank with all her crew of nearly 600 men, On the 16th June, 1836, a 24-pounder brass gun, 11 feet in length, belonging to this vessel, was raised with the aid of diving apparatus. This gun had a cast-iron shot in it, which on exposure to the air, is stated, became nearly red-hot and fell to pieces." "At the same time," Mr. Wilkinson writes, "four brass and three iron guns were raised from the wreck of the *Mary Rose*. The iron guns were of the ancient description, formed of iron bands hooped together with iron rings, and they were all loaded, but the guns being made of wrought or malleable iron did not exhibit the same phenomena as the balls, which were made of cast-iron. Those balls, which by their diameter ought to have weighed 30 lbs., were reduced to 19 lbs. 3 ozs. The 8-inch or 70-lb. ones were only 45 lbs., and although to external appearance, the same as regular shot, they fell to pieces *red-hot* on exposure to the air."*

No complete analyses seemed to have been made of the graphite-like residues; hence no comparison could be made between the composition of this specimen from the "Hunter" and that of others.

Dr. Percy refers to some experiments made by Professor Daniell.† A cube of grey cast-iron was acted upon by dilute hydrochloric acid. When the acid was saturated the cube was taken out and found to consist of a soft spongy substance, but apparently undiminished in bulk. A specimen of white cast-iron having a radiated fracture was similarly treated; the dark grey spongy residuum could be easily cut with a knife and resembled plumbago. Some of it when placed to dry on blotting-paper spontaneously heated and smoked in the course of a minute. In another case when a considerable quantity of it had been heaped together it ignited and scorched the paper.

But the most valuable contributions to our knowledge upon this subject were made by Mr. Robert Mallet, F.R.S., in his Reports to the British Association for the years 1838, 1840, and 1843. These reports were made at the request of the British Association, and they contain the results of a most careful and elaborate series of experiments made to ascertain the action of sea and river water, both clear and foul, and at various temperatures, upon many hundred specimens of cast and wrought iron and steel, as well as to test the advantages of various protective paints and varnishes; they also contain the results of experiments made to ascertain the protection afforded by zinc, &c., to iron structures in contact with water.

* Percy's "Iron and Steel," p. 147.

† Percy's "Iron and Steel," p. 146, quoting from the *Journal of Science and Art*, vol. ii., p. 278.

Mr. Mallet mentions a case* in which bars of cast iron 3-inches broad and 1-inch thick, which formed protectors to the copper of a vessel, to the amount of about $\frac{1}{10}$ of its surface, were in a voyage of not quite five months to Jamaica and back, converted into plumbago to the depth of half an inch; this statement is of special interest in connection with the specimen from the *Hunter*.

Mallet states that Priestley was one of the first of those who observed this conversion of cast-iron into a plumbago-like mass of mixed oxide of iron and carbonaceous matter, and that such residues frequently but not invariably became hot or spontaneously inflammable on exposure to the air. Mallet states that under certain circumstances even the purest malleable iron iron is converted into this plumbago-like substance, and quotes instances. The same writer mentions that some cannon-balls which were found in the sea near the site of the battle of La Hogue had, after an immersion of 145 years, been converted into plumbago to the depth of an inch in some cases and right through in others; and assuming their diameter to have been about 6¼ inches, the usual size of 32 lbs. shot, he points out that the iron had been destroyed to a depth of 3¼ inches during the above number of years,—a much more rapid rate of action than he obtained from his special experiments.

The foregoing will probably suffice as instances of the action of sea-water, brought about more or less by accident. Mr. Mallet's experiments are far too numerous to quote here—I can merely give a bare summary of his results.

Mallet found that the approximate depth of corrosion in clear sea-water at the end of one century would be as follows:†—

Welsh cast-iron.	Hot and cold blast	0·306 inch.
Irish ,,	Cold	0 306 ,,
Mixed cast-irons; Scotch and Welsh, Irish and Welsh, &c.,	.. ..	0·337 ,,
Scotch cast-iron.	Chiefly hot blast	0·379 ,,
Staffordshire, Shropshire, and Gloucestershire cast-iron.	Hot and cold blast ..	0·385 ,,
Grey cast-iron, mixed.	Skin removed by planing	0·419 ,,
Derbyshire and Yorkshire cast-iron.	Hot and cold	0·431 ,,
Wrought-iron.	Standard bar, No. 2 Dowlais	0·543 ,,

In another table‡ he gives the approximate depth of corrosion for the following wrought-irons and steels at the end of one century in clear sea-water, foul sea-water, in clear fresh water, and when freely exposed to the weather in Dublin:—

	Clear Sea-water.	Foul Sea-water.	Clear Fresh-water.	Exposed to the Weather in Dublin.
	Inch.	Inch.	Inch.	Inch.
Red-short bar, Staffordshire	0·276	0·644	0·032	0·335
Common bar, Shropshire	0·927	0·434	0·081	0·540
Best bar, Staffordshire	0·316	0·423	0·039	0·361
Best Welsh bar, Dowlais	0·278	0·638	0 035	0·353
Low Moor boiler plate	0·215	0 404	0·035	0·332
Common boiler plate	0·272	0·554	0·038	0·412
Swedish bar, Danemora	0·277	0·726	0·030	0·470
Fagoted scrap bar..	0·064	0·379	0·024	0·219
Blister steel bar, soft	0·298	0·425	0·015	0·301
Shear steel bar, soft	0·313	0 676	0·025	0·389
Cast steel, tilted bar, soft	0 441	0·559	0·026	0·279
Cast steel, tilted bar, hard	0·239	0·430	0·043	0·156

* "British Association Report," vol. viii., 1838, p. 262.
† "British Association Reports," 1840, vol. x., p. 299.
‡ "British Association Reports," vol. xiii., 1843, p. 53.

As in the former table the results were obtained from specimens which had been immersed for 732 days.

Mallet found that the corrosion of cast-iron, which has had its skin removed by planing, is precisely the same in moist air as in clear sea-water, also that the rate of corrosion of cast iron in sea-water is a decreasing one, when the coat of plumbago and rust first formed is removed prior to a second immersion. When the coating is untouched the corrosion goes on at a nearly uniform rate. The coating of plumbago and rust is negative to the metal; hence, when left on, it assists in the corrosion of the metal; in fresh-water this is not so strongly marked, since the coating is harder and less porous; thus to a greater extent it mechanically defends from corrosion.

The rapid action of sea-water upon cast-iron and the commoner varieties of wrought-iron is probably due mainly to the local galvanic action set up between the diffused scales of graphite, films of slag, or other foreign matter.

Where cast-iron is exposed to the combined action of fresh-water and of sea-water, as at the mouths of rivers, the action is said to be much more rapid, for the heavy sea-water remains below while the lighter fresh-water floats above, thus producing a voltaic pile having two liquids and one solid, also in places where the sea-water is foul and more or less contaminated with sulphuretted hydrogen.

The action of acid waters in copper and other mines, and of solutions of the salts of copper upon iron is well known, and it is taken advantage of by the miner in the humid or precipitation processes for the extraction of copper. It is quite a common thing for workers in certain mines to find neglected articles of cast-iron which have been exposed to the action of "acid" waters converted into masses of graphite-like matter.

The action of sea-water upon iron, and especially upon cast-iron structures, must be one of very great interest and importance to engineers; it is certainly one well worthy of further investigation, especially in connection with the construction of cast-iron cylinders for the support of piers and wharves in harbours and estuaries. The copper sheathing of ships and the metal of cast-iron wharves would form a galvanic couple if connected in any way either by actual contact, by wet hawsers, fenders, or by other means affording a passage for the electric current.

Mallet refers to the well known rapidity with which recently made castings become coated with rust when exposed to a shower of rain, and he states that it takes place much more rapidly in the case of castings made in "dry sand" or "loam" than in those made in damp or "green sand" moulds. He says, "in 'loam' or dry sand moulds, moisture not being present, but little hydrogen is generated by the fluid metal to burn off the 'facing' of charcoal which remains '*parsemé*' on the surface of the casting, producing innumerable voltaic couples in contact with water; while in the case of the 'green sand' castings, most of the charcoal facing is removed in a gaseous form from the casting before it leaves the sand." But I am inclined to think that this difference is probably due in part, if not wholly, to the formation of a film of magnetic oxide of iron by the steam from the moisture: the protective action of such a film has long been known, although it was not made use of on a large scale until Mr. Barff, the Professor of Chemistry at the Royal Academy, brought out his process.

Liverpool College of Chemistry.—This institution, which was founded in 1848 by the late Dr. Sheridan Muspratt, has apparently been for some time in abeyance. It has now, however, been re-opened by Drs. Tate and Granville H. Sharpe, and bids fair to enter upon a career of usefulness. We learn that the laboratories have been enlarged and refitted in accordance with modern requirements and present every facility for research, for the execution of commercial analyses and assays, and for instruction in chemical science. We cordially hope that the college may prove a focus of sound and thorough-going work.

ANALYSES OF SOME GEYSER DEPOSITS.

By HENRY LEFFMANN, M.D.

The following analyses are submitted as a contribution to the chemistry of the interesting region known as the Yellowstone National Park. The phenomena of geyser action are seen in great extent and variety in this region, and the chemical characters of the waters and deposits are important points in studying the geology and physical geography. I am indebted to Dr. A. C. Peale, of the U.S. Geological Survey of the Territories, for the specimens. They were all collected by him in 1878. I expect, before long, to submit further interesting results in regard to these deposits.

1. From Black Sand Geyser in Upper Geyser Basin.—Hardness 6·5 to 7·0; sp. gr. 2·08. A slightly stratified mass of mixed white and flesh colour giving much the appearance of felspar.

Silica	94·0
Alumina and ferric oxide	1·0
Water	5·3
	100·3

2 From Yellow Crater Spring in Shoshone Geyser Basin.—Compact white mases distinctly stratified. Hardness 6·5 to 7·0.

Silica	94·0
Alumina and ferric oxide	traces
Lime	0·1
Water	5·2
	99·3

3. From Witch Creek in Heart Lake Geyser Basin.—Snow-white masses stained by iron oxide in spots. Not stratified. Hardness 7·0.

Silica	94·1
Water	1·0
Alumina, &c.	not determined

4. Geyserite from Pearl Geyser in Gibbon Geyser Basin.—Porous and slightly greyish masses; upper surface smooth and finely mammillated. Hardness 6·0.

Silica	87·1
Water	10·6
Alumina, &c.	undetermined

5. Pebble of Geyserite from basin or bowl of Rustic Geyser, Heart Lake Geyser Basin.—Double convex greyish white mass, evidently rolled by water. Hardness 5·5.

Silica	90·0
Alumina and ferric oxide	2·6
Lime	1 6
Water	5·0
	99·2

6. Geyserite from Deluge Geyser, on Witch Creek, Heart Lake Geyser Basin.—Clay-like fawn coloured moss; upper surface with numerous stalactitic projections. Hardness 5·0.

Silica	19·0
Water	8·0
Alumina, &c.	undetermined

7. From Rustic Geyser, Heart Lake Geyser Basin. Masses resembling drusy quartz.—The water from this geyser coats wood, and one of the specimens of the deposit encloses a piece of wood. Hardness 5·5 to 6·0.

Silica	87 3
Alumina with traces of iron	2·2
Water	10·3
	99·8

The above minerals represent two sub-species of the quartz group. Nos. 4, 5, 6, and 7 are *geyserites*, distinguished by the eight to ten per cent of water (No. 5 is exceptional), and not over 90 per cent of silica. Nos. 1, 2, and 3, show less than 6 per cent of water and about 94 per cent of silica. A specimen of this composition was first analysed by Dr. F. M. Endlich, and reported by him in the "Report of the U.S. Geological Survey for 1872," page 153. To this variety the name *Pealite* has been given in honour of the collector.

920, Walnut Street, Jan. 31, 1881.

ON THE RELATIONS BETWEEN THE ATOMIC WEIGHTS.

The hypothesis of Prout, according to which the atomic weights of the elements are exact multiples of the atomic weight of hydrogen = 1, has been long ago shattered by the researches of Schützenberger. By means of careful investigations and the application of trustworthy methods, a series of atomic weights have been determined on comparing which it would be in vain to search for a common factor. But there are certain relations between the atomic weights of the elements of one and the same group, as was pointed out by Dumas, and which have been more closely examined by Gerber. He finds for the monatomic elements the common factor 0·769, for the oxygen and magnesium group, as also for carbon, silicon, and certain other elements, the factor 1·995; for the nitrogen group along with boron, bismuth, and gold, 1·559, and for the other metals 1·245. These factors are purely empirical, without mutual relation, and in themselves of no value. Whether the detection of such numerical relations will be of real service to chemical research must remain undecided. —*Chemiker-Zeitung.*

THE ALKALOID FROM PITURIE.*

By Professor LIVERSIDGE, Assoc. R. S. Mines, F.I.C.

I am indebted to the kindness of Mr. de Renzie Wilson, of Bangate Station and the Retreat, Barcoo River, for the supply of piturie upon which this investigation was conducted, also to other friends who placed some smaller quantities at my disposal. Mr. Wilson had considerable difficulty in procuring a sufficient supply for my purpose; he states that the blacks prize it very highly; so much do they value it that it can only be obtained from them in very small quantities at a time, hence it involves the expenditure of much time and trouble to collect together a few pounds weight of the substance. The blacks in his district on the Barcoo obtain it from the Diamantina blacks who trade yearly with the Mulligan or Kykockodilla tribe, in whose country the piturie grows. One parcel which Mr. Wilson sent to me was some months in transit, as it had to be carried down on camels to Port Augusta; the sea journey from Port Augusta to Sydney was of course a question of only a few days.

The first parcel of piturie was in the form of broken twigs, and fragments of leaves of a pale brown colour, emitting a smell somewhat similar to tobacco; the fine dust causes sneezing. This is its usual state, but the second parcel forwarded by the camels was much less broken up and was of a darker colour, the difference being probably due to the less careful drying which it had undergone, for, as Mr. Wilson explained in his letter, the camels started earlier than was expected, and in consequence the piturie had to be packed up before it was thoroughly dried.

Unfortunately none of the samples contained either flowers or seeds, but I have but little doubt that the piturie

* A Paper read before the Royal Society of New South Wales, November 3, 1880.

supplied to me was obtained from the plant *Anthocercis Hopwoodii*, since known as *Duboisia Hopwoodii*;* (F. v. M.), and now named *D. Pituri* by Dr. Bancroft;† one of the Solanaceæ.

Dr. Bancroft gives the following description of the piturie plant:† "The piturie grows about 50 miles east and west of the 138° meridian, the boundary between Queensland and South Australian territory, and from 22° to 25° south latitude. It is a shrub or small tree about 8ft. high, with a stem at the thickest part at times as much as 6 inches in diameter. Wood light, close-grained, lemon-coloured, with a smell of vanille when newly cut. Suckers spring up around the tree, from long, rough roots spreading near the surface. Leaves 3 to 3½ inches long, pointed at both ends, ½ inch wide, mid-rib distinct, margin slightly recurved; flower, a funnel-shaped tube, from ¼ to ⅜ of an inch long, with five bluntish divisions, spreading to about ¼ inch across. Three reddish lines run from each division down the throat of the flower, as in the genus *Myoporum*, which latter may be known by having four or five stamens of equal length. The pistil of the pituri extends to the length of the two longer stamens. Stamens four, two long and two short; anthers, yellow, kidney-shaped, filament attached to the concave side, the anther bursting along the convex margin; best seen by examining a flower that is just at the point of opening. Fruit, a green berry resting in the minute calyx. As it ripens it changes to black, and contains dark-brown kidney-shaped seeds, covered with minute pits, recognisable by the aid of a pocket lens. Ripe berries soon fall off, and should be looked for under the tree, as those gathered from the branches are not mature enough to germinate."

Mr. Wilson informs me that the blacks mix the piturie with the ashes of the leaves of a particular plant and usually roll the mixture up with a green leaf into the form of a quid before chewing; the addition of the wood ashes is doubtless made for the same reason that lime is mixed with betel by the Malays and others, namely, for the purpose of slowly liberating the alkaloid during the process of mastication. The quid or bolus is, on ceremonial occasions, said to be passed from native to native, each one masticating it for a time, and then passing it on, it finding a resting place behind the original proprietor's ear until again required.

The effects of the piturie seem from all acounts to be very much the same as those set up by tobacco-smoking; it does not appear to have the exciting effect upon the blacks with which it was at one time credited. As is the case with other luxuries, it is reserved by the older men for their own use exclusively, neither women nor young men being allowed to use it. The reasons for using it appear to be much the same as those which induce white people to smoke and in certain cases chew tobacco.

I have made no attempts to experiment upon the physiological effects of the alkaloid, since this part of the subject has been very fully treated by Dr. Bancroft and other observers. The examination was made mainly with the view to ascertain its chemical composition, and, if possible, constitution. The supply of alkaloid was insufficient to admit of both questions being treated.

In a letter dated September 5, 1879, the Baron von Mueller, K.C.M.G., has been kind enough to place at my disposal the following account of the alkaloid obtained by him from piturie, which is the substance of a paper of his read before the Apothecaries' Society of Vienna:—

"For the preparation of piturine and pituric acid the branchlets and leaves of *Duboisia Hopwoodii*, F. v. M., were subjected to exhaustion by boiling water, the infusion evaporated to honey thickness, then mixed with three volumes of alcohol, the resulting solution evaporated to the consistence of an extract, the latter dissolved in water and precipitated by basic acetate of lead. The precipitate separated by filtration contained a peculiar acid substance, while the filtrate, after sufficient concentration and after mixing with an excess of caustic soda solution and ether, yielded to the latter the alkaloid which was purified by agitating its etherous solution with diluted sulphuric acid, thereby forming the sulphate of piturine. The aqueous solution of the latter was then again decomposed by caustic soda, the pure alkaloid removed by ether, and the solution evaporated at a gentle heat. It formed a brownish liquid of oil-like thickness, heavier than water, of acrid and burning taste and tobacco odour, much affecting the organs of sight and respiration. It is volatile and forms fogs with diluted hydrochloric acid, is of strong alkaline reaction, and combines thoroughly with acids.

"Its hydrochloride forms precipitates with the chlorides of platinum and gold, with picric and tannic acids, phosphomolybdate of soda, bi-iodide of potassium, the iodide of potassio-mercury and potassio-bismuth, also with phosphowolframate of soda,* but this precipitate is easily dissolved in an excess of this reagent. Piturine mixes with every proportion of water, alcohol, and ether. Concentrated hydrochloric and nitric acids do not affect a colouration with it; concentrated sulphuric acid forms reddish-brown clouds and dissolves to a brownish-green liquid. The yield was about 1 per cent of alkaloid from the dried plant.

"Piturine is in some respects allied to nicotine, but more closely akin to the duboisine of *Duboisia myoporoides* (R.Br.), the latter being of lighter colour, of bitter not acrid taste, of fainter odour, less irritating to the eyes and respiratory passages; its hydrochloride in solution is not precipitated by chloride of platinum, but is so by phosphowolframate of soda, and the precipitate is not re-dissolved by a superabundance of that reagent."

A. Ladenburg, *Comptes Rendus*, 1880, vol. 90, p. 874 to 876, however, states that the alkaloid of *Duboisia myoporoides* is identical with hyoscyamine, and that it crystallises in small needles, fusing at 108·5° C., and is isomeric with atropine, from which it is distinguished by forming a brilliantly lustrous compound with gold chloride, fusing at 159° C. Also when treated with baryta it is converted into *tropine* and *tropic* acid, both of which are also obtained from atropine.

The great discrepancy between A. Ladenburg's account and the Baron von Mueller's can, I think, be only accounted for by the supposition that Ladenburg must have been supplied with a different material. Baron von Mueller and Rummel (*Jour. Chem. Soc.*, January, 1879), state very plainly that the *Duboisia myoporoides* yields a *volatile oily* alkaloid, and this is again confirmed by the extract from the Baron's letter, already quoted.

In the same paper Baron von Mueller also describes pituric or duboisic acid obtained from the precipitate given by the piturie on the addition of basic acetate of lead.

In the *Pharmaceutical Society's Journal* for April 5, 1879, there is an account of an examination of some piturie made by M. Petit, of Paris, in which he comes to the conclusion that the alkaloid is identical with nicotine; but M. Petit does not seem to have had sufficient material to permit a combustion to be made of the alkaloid; he had to rely mainly upon its reactions with certain chemicals, and apparently was only able to make one determination each of the platinum and chlorine in the platinum salt; the amounts of which apparently roughly corresponded with those required for the chloro-platinate of nicotine, viz., 34·4 per cent platinum and 37 per cent chlorine, the percentages obtained being platinum 34·0 per cent and chlorine 36 per cent. These results, however, cannot be regarded as final, since, as will be shown later on, the platinum salt cannot be depended upon, as it is not of uniform composition.

Preparation of the Alkaloid.

The piturie was extracted with boiling water slightly acidified with sulphuric acid, the liquid concentrated by evaporation and distilled with an excess of caustic soda,

* *Frag. Phytograph.*, x., 20, Baron von Mueller.

† Piturie and Tobacco, by Dr. Bancroft, *Jour. Queensland Phil. Soc.*, 18; 9.

* Metatungstate of soda.

the alkaline distillate neutralised by hydrochloric acid, evaporated over a water-bath until reduced to a small bulk; as the residue was of a yellowish colour it was once more distilled with caustic soda, the distillate neutralised with hydrochloric acid and again concentrated; it was now nearly colourless, caustic soda was again added, and the liquid shaken up with ether.

The ether was next removed by distillation at as low a temperature as possible in a current of hydrogen, the heat meanwhile being raised gradually until it reached 140° C., a bath of sulphuric acid being used for this purpose. It was allowed to remain at this temperature for about six hours; the bath was then removed, and the distillation continued at a still higher temperature over a naked flame, the current of hydrogen being still maintained, until all the alkaloid, with the exception of a very small quantity, which had become charred, had passed over in a clear and colourless condition. During the distillation the thermometer indicated a temperature between 243° and 244° C.

I. 60 grms. of the substance gave 0·622 grm. of the alkaloid, or 1·037 per cent. In this case the alkaloid was not allowed to boil, but was maintained at a temperature of 140° C. in a current of hydrogen for several hours, to remove water and traces of ammonia.

II. In a second experiment 500 grms. of the piturie gave 12·34 grms. of alkaloid, or 2·47 per cent, when distilled in a current of hydrogen.

The piturie did not contain any non-volatile alkaloid.

The alkaloid when freshly prepared is clear and colourless, but with access of air rapidly becomes yellow, and finally brown, especially when exposed to the sunlight. In a sealed tube one specimen has remained unchanged during the past eight months.

It is soluble in all proportions in water, alcohol, and ether, yielding colourless solutions. On paper it produces a greasy stain, which disappears after a time.

No determinations by weighing have yet been made of its specific gravity, but it is just a little heavier than water, a drop of it sinking slowly to the bottom of a vessel of distilled water.

When freshly prepared its smell is very like that of nicotine; afterwards, when darkened in colour and thickened in consistency, the odour is more like that of pyridine.

It is volatile at ordinary temperatures, its vapour forming a dense fog with hydrochloric acid. Its vapour irritates the mucous membranes very much, and when working with it induces violent headaches.

The taste is acrid and pungent, and very persistent.

It neutralises acids completely; but the neutral solutions of acetate, sulphate, and hydrochloride all become acid on evaporation from the loss of alkaloid.

Oxalic acid is the only acid which yields a crystalline salt, but this is more or less mixed with free acid, from the loss of alkaloid by volatilisation, an acid salt mixed with free oxalic acid being left.

The acetate, sulphate, and hydrochloride, when kept over strong sulphuric acid, dry up into hard, brittle, transparent, varnish-like substances, without the slightest trace of crystallisation, even after standing for months. All these compounds are very hygroscopic, especially the sulphate, and are very readily soluble in alcohol.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, March 12, 1881.

SIR W. THOMSON in the Chair.

NEW members—Mr. Colville Brown, Dr. J. P. Joule.

Col. FESTING read a paper by Captain ABNEY and himself "*On the Absorption-Spectra of Organic Bodies.*" The method of photographing the infra-red region of the spectrum gave better results for absorption than the thermopile. Organic compounds were chosen as giving the larger molecules. The apparatus employed consisted of a small Gramme machine driven by a Brotherhood engine, and an electric lamp with a device for shifting the negative pole, so as to get the crater on one side of the other carbon point. The image of the positive pole was allowed to fall on the slit of the spectroscope, the light of the arc not being used. Three prisms were used and a camera with a back swing to it, so as to get a considerable length of spectrum in focus. Maps of the various spectra were made with six inches of the substance examined enclosed in a glass tube. Alcohols, acids, oils, and water were examined, and some spectra of bands and lines. When hydrogen was absent in the compound there were no lines, and the authors conclude the lines to be due to hydrogen. Oxygen appeared to obliterate the space between two lines and make it a band. The authors hope by this method to detect the radicles present in a substance. They found correspondences between some lines, and lines in the solar map.

Dr. COFFIN said that two kinds of chloroform apparently the same produced different physiological results: the method might distinguish between these.

Sir WILLIAM THOMSON thought it might throw light on the ultimate constitution of matter.

Mr. BROWN read a paper on the "*Definition of Work in Text-Books*," and gave reasons for preferring that in Rankine's books.

NOTICES OF BOOKS.

Experimental Chemistry for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., Professor of Chemistry, University of Dublin. Part I., Introductory. London: Longmans, Green, and Co.

WERE this book one of the routine elementary treatises on chemistry which appear season after season in such unaccountable profusion, and which drive reviewers to despair, we should be compelled to dismiss it with a sentence or two purposely devoid of deep meaning. But even on a very superficial inspection it appears that Dr. J. E. Reynolds fills a distinct and readily defined position. He builds his course of instruction from the very outset upon experiments. The student is to learn not from the words of the book, but from certain facts, presented in a simple and natural order. The task which the author undertakes is to show how these facts are to be brought before the eyes of the learner. Nothing is advanced which is not thus distinctly placed in evidence. Thus the difference between physical and chemical action, the determination of the latter by mechanical force, by light, electricity, &c., are not laid down as something to be accepted, with or without a clear understanding, but are shown in action. Hence the knowledge of chemical science acquired by students who follow the course here laid down will be from the very first clear and thorough. It is therefore reasonable to suppose that they will continue in the same direction, and as their knowledge extends, and as some of them perhaps, not content with acquiring what has been discovered by others, press on to extend the boundaries of the science, they will still continue at every step to call for experimental evidence. Chemistry thus acquired may be even more valuable as a process of mental discipline than from the mere facts or the deductions inculcated. It will teach the student how to draw right conclusions from facts correctly observed; and how much of the business of life is summed up in these few words! The experiments here described are simple, and the apparatus needful is cheap and easily procurable. Hence we may with a good conscience recommend this little book alike

to private students and to the heads of schools who are hesitating about the introduction of chemistry into their curriculum.

The Ventilation of Dwelling-Houses, and the Utilisation of Waste Heat from Open Fire-places, including Chapters on London Smoke and Fog, Modern Fireplaces, &c. By F. Edwards, jun. London: Longmans, Green, and Co.

The fogs of the winter of 1879-80 seem to have made a deep and lasting impression, not merely upon the lungs, but upon the brains of a great part of the community. With the question of the origin and possible abatement of this nuisance, certain collateral subjects, such as the warming and ventilation of our houses, are very closely connected, and are being discussed not merely by scientific and semi-scientific personages, but by the general public. As a community we have to take heed lest in throwing off the ills we have so long borne with patience we do not incur such as are greater. Bearing in mind what an insignificant fraction of heat-giving power we obtain from the fuel burnt in our dwellings, it may surely be demanded that the reform adopted, whatever it be, should before all things involve a reduction and not an increase of cost.

The work before us criticises incisively, but not unjustly, many of the "improved" methods of warming which are now urged upon our attention. The writer recognises the value of gas for cooking, but, unlike Dr. A. Carpenter, he shows very good grounds for doubting its general utility or economy for warming rooms. The proposed tax on fireplaces not so constructed as to burn their own smoke he condemns. It would be, in fact, as oppressive an enactment as was ever forced upon a conquered country, since it would fall upon those who have not the means to make alterations in the houses which they inhabit.

Anthracite is difficult to kindle, and is out of court in those multitudes of cases where one and the same open fire has to serve both for warming and cooking. What, moreover, would be its price if all other coal were interdicted in London? The author refers also to the proposal of having the fuel partially freed from its volatile constituents at the gas-works, as expounded in a paper recently read before the Society of Arts. According to the propounder of this scheme the coal thus treated is to be sold at 23s. per ton, which is far too high for the interest of the community. As regards Mr. Spence's scheme of carrying all the fire-gases into the sewers and discharging them through a chimney 600 feet high and—in case of Manchester—100 feet in diameter, the author points out certain serious engineering difficulties, and calculates that the chimney would require a diameter of 720 feet! We do not join him in his opinion that the plan of heating houses entirely by hot water, steam, or hot air "is quite inapplicable in so variable and temperate a climate as ours." This system of heat, as is proved in conservatories, admits of being most nicely regulated according to the external temperature. But except in large buildings, or where a whole row of houses is to be heated simultaneously, it is utterly inadmissible on the score of cost.

The author's own schemes have in them nothing of a startling character. In kitchens he would have ovens and boilers heated from below by means of a closed stove fed with anthracite. We may here remark that the plan of heating ovens from above, as now common in London and the south of England, is an absurdity devised by some ironfounder, careless or ignorant of the laws of heat, and anxious chiefly to dispose of a maximum weight of cast-metal. For dwelling-rooms he proposes a special fire-grate fed from below by dint of a special contrivance which is here figured. In consequence there will be little smoke given off except when the fire is first kindled. There is another very important point by which much heat would be economised. In our present houses the column of heated air ascending from the fires in the lower stories is enclosed within such thick masses of masonry that it contributes nothing towards improving the temperature of the upper rooms. Mr. Edwards, therefore, proposes to convey the products of combustion upwards through iron, or possibly stoneware, pipes, so that they may warm and dry the bedrooms. He gives diagrams showing the necessary arrangements. Here, however, the individual is utterly powerless.

As a further improvement he suggests the use of double windows, such as are very common on the Continent, or, if these be too costly, double panes of glass, fixed at the distance of a quarter of an inch from each other, but in the same frame. However, so long as the sashes, doors, &c., are constructed in the present disgraceful manner, these arrangements would be of little service.

On the subject of ventilation the author seems too anxious. He apparently overlooks the fact that except the walls of a house are constructed of marble, or are coated within with varnished papers or oil-paint, a constant interchange of air takes place through the bricks or stones themselves. The ventilation effected by an open fireplace is unsatisfactory, as it affects chiefly the lower part of a room, leaving a reservoir of impure air next the ceiling, which is only very slowly and imperfectly removed. The lower the firegrate is fixed the more decidedly is this the case.

Mr. Edwards thinks it hopeless to induce the English public to take to close stoves. But when and where has a fair trial been made with a fireclay stove as used in Germany? We for our part should give it the preference. On a great number of points we decidedly agree with the author, and consider that he has hitherto scarcely met with fair treatment in attempting to bring his views before the public. In these days the question is not so much what is said as by whom it is uttered.

CORRESPONDENCE.

THE ATMOSPHERIC OXIDATION OF MOIST PHOSPHORUS.

To the Editor of the Chemical News.

Sir,—In his recent article (Chemical News, vol. xliii., p. 97), Dr. A. R. Leeds has said so much about me and my work, that for the purpose of avoiding permanent misrepresentation, I am bound to claim your indulgence to enable me to reply very briefly upon this subject.

In the first place, I am charged with a change of views. I do not object to this particularly, but it would have been more agreeable had Dr. Leeds allowed that I had rather extended than changed my views. From the outset of this discussion, I was convinced that peroxide of hydrogen would be found as a chief product of the atmospheric oxidation of phosphorus, and having been largely concerned with the production of this substance by other chemical processes of limited oxidation, it was to be expected that this part of the subject would have, for me, more interest than the possible simultaneous formation of ozone. Moreover, at that time, it was thought hardly possible for ozone and peroxide of hydrogen to be present in mixture, for, as Prof. H. McLeod said in his paper (*Jour. Chem. Soc.*, 1880, p. 120), "the bodies mutually decompose one another under certain conditions."

For all that, however, I am never ashamed of a change of opinion. To every scientific man change of opinion is inevitable, because it is coincident with the progress made in science. Dr. Leeds has experienced this fact also, for at one time he stated (Chemical News, vol., xxxviii., p. 236), ozone to be produced by the action of oxalic acid upon potassic permanganate, and at a subsequent time (vol. xxxix., p. 18) retracted this opinion.

I may at once state that I shall pass over much of what is put forward by Dr. Leeds, simply because it is undoubtedly hypercritical or even more unworthy of serious considera-

tion, and shall confine my reply to certain salient points in the subject under discussion.

Dr. Leeds endeavours to explain away the fact that he entirely overlooked the presence of peroxide of hydrogen in the water containing the phosphorus, but the fact remains that, in his paper (Chemical News, vol. xl., p. 73), he merely determined that substance contained in the washing-water. How far this was accidental is nothing to me, but I may remind him that in a much later communication (vol. xli , p. 165), he repeats the omission, and as the result of his investigation says, without limit or reservation of any kind, that the percentage of peroxide of hydrogen, as related to the air aspirated, "was 0·00038," or "but 1-400th part of the ozone."

Next, Dr. Leeds unfairly represents my criticism of this result. He says, I charged him with looking for hydrogen peroxide in an acidified potassium bichromate solution. Not at all. Finding that he did not examine, for peroxide of hydrogen, the water (where used) in which the phosphorus was partially submerged, I said the use of bichromate in the other cases "precluded examination." I submit that my criticism will not bear Dr. Leeds's interpretation.

Dr. Leeds may rest assured of the fact that I used pure water, although I did not style it "*aqua purissima*," and that I avoided all real sources of error. Indeed, as will be evident to any chemist who compares our results, the investigations made by Dr. Leeds, and my own research, lead practically to the same conclusions. The chief matter on which we disagree I shall refer to hereafter and emphasise. In the meantime, I claim for my research that it once for all and for the first time proved that peroxide of hydrogen ranks in importance with ozone as a product of the atmospheric oxidation of phosphorus; it also explained the absorption of the whole molecule of ozone by turpentine, and it furnished some useful information regarding the reactions of peroxide of hydrogen and the methods employed for estimating that substance.

The peroxide of hydrogen I found to be entirely dissolved in the water containing the phosphorus. The washing-water through which the gas from five oxidisers was passed, gave the merest traces of this substance, and the other active product (ozone) was, on the one hand, entirely absorbed by turpentine and, on the other hand, destroyed by exposure to 240°. Apparently, nothing could be more conclusive; but Dr. Leeds will have it that peroxide of hydrogen passes from the oxidisers, escapes through the washing water, fails to be absorbed or decomposed by a solution of strong sulphuric acid and by passing through tubes 2·5 metres in length containing beads moistened with the same acid, but is at length decomposed by exposure to an elevated temperature, and he claims to have weighed the water thus formed. Now in the *Journal of the Chemical Society* (1880, p. 799), I have shown that even if we trust the figures of Dr. Leeds, the rise in the water produced does not follow the increase of temperature as laid down by that experimenter. But what is more, I distinctly challenge the accuracy of the figures, and I do not believe that any water was produced. Dr. Leeds says, 0·016 grm. is a ponderable quantity. So it is, but let us see how he arrives at this ponderable quantity. In twelve experiments his test apparatus increased in weight as follows (see Chemical News, vol. xlii., p. 19):—

0·0015; 0·0010; 0·0000; 0·0010; 0·0011; 0·0002; 0·0015; 0·0003; 0·0000; 0·0018; 0·0002; 0·0000.

These figures summed up give 0·0086 grm., and if we assume the increase in each case to have been due to water resulting from the previous decomposition of peroxide of hydrogen, then the total amount would be equivalent to 0·016 grm. H_2O_2. But for my part, I do not think this is a fair way of obtaining a ponderable quantity.

Dr. Leeds used 12 litres of ozonised air in each experiment; sometimes he got no increase at all in the weight of his test-apparatus, and where he did get an increase, the amount even in the most favourable instances was scarcely outside the recognised limits of error. In fact, in my opinion, Dr. Leeds has given us here not a ponderable quantity of water, but the sum of twelve errors of experiment. Moreover, in these twelve experiments, Dr. Leeds found a total quantity of 0·00029 grm. of hydrogen peroxide in all his washing water, but again he has neglected the water in the vessels in which the phosphorus was oxidised, which water I have shown to contain practically all, or quite all, the peroxide of hydrogen which is produced, and this is so large in amount as to offer no difficulties in its proper estimation.

I am perfectly well aquainted with the white cloud that forms in the oxidisers, and which is more or less persistent to the end of the apparatus. When the current of air was sufficiently slow there was really no cloud observed at the end of my apparatus. In the Chemical News (vol. xl., p. 74), Dr. Leeds speaking of the white fumes in the ozonators said, "they are chiefly due to phosphoric anhydride," so I suppose it must be only at the other end of the apparatus that the fumes become antozonic in nature. Again (vol. xli., p. 164), Dr. Leeds says, speaking of the white fumes observed over potassic iodide solution exposed to the ozonised air, "this white cloud is the antozone of Schönbein and other authors. It is, in fact, peroxide of hydrogen held in a state of aqueous solution, *and is the product of the action of the ozone upon the potassium iodide solution.*" I should like to see the proof of this statement, but I am afraid that is a pleasure which will be denied to me.

One other point and I have said all I intend to say just now upon this subject. Dr. Leeds thinks that turpentine may absorb peroxide of hydrogen in this antozonic condition. Well, he is safe in taking refuge under a supposition that cannot be tested, so far, experimentally. But there is this to be said, that, under ordinary laboratory conditions, oil of turpentine does not absorb peroxide of hydrogen, but on the other hand,—and this is very significant as regards the argument—it gives rise to that substance by its aërial oxidation in presence of water. Indeed, to my mind Dr. Leeds's proposition is indefensible on every chemical ground.—I am, &c.,

C. T. Kingzett.

BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—Having had some years' experience in testing benzols, &c., I find from that experience the points to be observed are:—1st. Uniform capacity and thinness of retorts; 2nd. Thin-bulbed thermometers with solid stems of proved accuracy; 3rd. Heating retort with hot air, and not by flame impinging on retort; this is accomplished by supporting retort on ring from which depends a cylinder of wire gauze, about 1¾ inches diameter and 6 inches long; the burner, with flame about an inch long, placed inside cylinder, and raised or lowered until boiling is regular. 4th. Barometric pressure of atmosphere at time of making test. 5th. Treating the process as a *technical* one, suitable to the requirements of *tar distillers* and aniline makers; not to be "improved" upon by every manipulator who fancies the process a "stupid" one, and in his opinion therefore inaccurate.

One *trial* of the apparatus your correspondent, Mr. Wm. Thomson, suggests, will be sufficient to demonstrate which, in the opinion of manufacturers, is the "stupid" process.

Finally, from my experience in these matters, I find that when the conditions imposed by the instructions, and allowed by *general* experience, are adhered to, the test as now used is remarkably accurate; and, further, commercial honesty, or *dishonesty* might I say, has a great deal to do with disputes arising from sale and purchase of benzols, &c.—I am, &c.,

William Bettel.

Analytical Laboratory and Assay Office,
The Grove, Worcester.

BENZOL TESTS.

To the Editor of the Chemical News.

Sir,—The letter of your correspondent, W. Thomson (Chemical News, vol. xliii., p. 115), calls for a few remarks. It was not my intention to take part in this controversy again. I had hoped that other tar chemists would have taken up this question, the importance of which may be seen when it is realised that some two to three million gallons of benzol are annually produced in the United Kingdom—representing a value of over £500,000.

After enumerating the instructions or details for testing, as usually printed on contract notes, Mr. Thomson proposes a new form of apparatus for the testing of benzols, which apparatus would require precisely the same attention to detail, size of flask, condenser, &c., would certainly be more trouble, would take from two to three hours each test, and would have the further disadvantage of not being so accurate or reliable as the present method—"stupid process," as Mr. Thomson calls it. If Mr. Thomson had had a few weeks' experience in the benzol refinery, he would not have been at the trouble of drawing the sketch of his apparatus, which, though it may not have been published before, is not new. Again, in testing benzols, there are other important points to be taken into consideration besides the percentages at 100° C. and 120° C., viz., the point of ebullition and the percentages at intermediate temperatures. Even supposing the apparatus would give accurate results at 100° C., it would be difficult to maintain steady temperatures at 120° C., 140° C., and 160° C.—points required in the testing of toluols, xylols, solvent naphthas. And for the purpose of testing crude naphthas containing benzol the apparatus would not be of the slightest use.

Wishing to give his apparatus a trial I, by means of a copper water-bath and retort, fitted up a similar apparatus, and placed in the retort 100 c.c. of 30 per cent benzol, a sample of which on testing on three successive days yielded exactly 31 per cent, the influence of the atmospheric pressure *not* being allowed for. After the water in the copper bath had been boiling about one and a half hours, 37 per cent distillate was recorded, whilst the thermometer in the retort had not registered more than 97° C.

The influence of an "aching void" within me being stronger than my faith in the process, I did not carry the experiment further, since the distillate had not ceased dropping. Just imagine a merchant, who had received half a dozen samples of benzol after dinner, the approval or acceptance of which he had to notify by return of post, having to test by this apparatus, or the works chemist who has the supervision of the benzol refinery. What anathemas would be poured forth! Mr. Thomson's remarks about the length of the bulbs of different thermometers are beside the question, since, as I mentioned in my previous letter, the thermometers used in various parts of the country for benzol testing vary but slightly, and in no instance would there be such a difference as 1 inch and fths inch. A sample of benzol carefully tested by different tar chemists in similar apparatus would not vary by more than 1 per cent, atmospheric pressure being disregarded. But I could not say the same with regard to the testing of a sample of benzol by different analysts who have had *little* experience in coal-tar products. Many interesting instances could be given of the wonderful results obtained by analysts to whom samples of benzols, carbolic acid, creosote oils, &c., have been submitted.

I remember a case in the Manchester district, where a disputed sample of naphtha had been referred to an analyst who came over to the works from whence it had been sent to be shown how to test it, and went away charmed with the simplicity of the test. In a day or so his analysis was sent in, and found to be wrong to the extent of 20 or 30 per cent. He charged two guineas for the analysis, but explained afterwards that he would test future samples for 2s. 6d. each. It is needless to say he earned no half-crowns from that firm.

I would here refer to the letter of "J. D." (Chemical News, vol. xliii., p. 93), in which he states that he allows 0·8 per cent for every degree (by which I suppose he means every 1-10th of an inch) rise or fall in the barometric column, and he mentions an instance where he had to make a parcel of 30 per cent benzol up to 42 per cent, because the barometer indicated at the time 28·5 inches. Since the buyers do not allow for barometric pressure, and a difference of 12 per cent means £30 or £40 per 1000 gallons, it would be a wise and profitable course for "J. D." to arrange with the Meteorological Office for reports of atmospheric changes. By judicious management he might arrange to deliver his benzol when the barometer was pretty steady; or, if he is inclined to be "cute," he might arrange for his benzol to reach buyer when the barometer indicated, say, 28·5, and thus pass 18 per cent benzol for 30 per cent: that is, supposing his statement to be correct, which is not so. Under ordinary circumstances the barometric pressure may be disregarded, under a great fall in the barometer; the result of the test might be affected 2 or 3 per cent, but not more. By the bye, does "J. D." correct his barometrical readings for temperature, and reduce to 0° C., and sea level? This, in many places, makes a difference of several degrees.

In conclusion, disputed tests of benzol are not so numerous as the correspondence would lead one to suppose—no more numerous than disputed tests in the alkali trade—and the "stupid process" in experienced hands is quite as reliable, if not more so, than many of the elaborate processes for the analysis of water, butter, milk, &c.—I am, &c.,

William W. Staveley.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 7, February 14, 1881.

Periodic Movements of the Ground.—P. Plantamour.—The author gives an account of his observations on the movements of the ground from October 1, 1879, to September 30, 1880. The most remarkable feature is the sinking manifested on the eastern side from the end of November, 1879, to the end of January, 1880, which is much greater than might be expected from the absolute cold of the month of December, only −15°. A rise of temperature is always accompanied with an elevation of the ground level, and a fall of the thermometer is marked by a subsidence.

The Laws which Govern the Periods and the Coefficients of Intensity in one of the Principal Groups of Elementary Electromotor Forces due to Solar Induction, and the Possibility of Using a Magnetic Needle to Measure the Speed with which the Sun Revolves on its Axis.—M. Quet.—A mathematical paper, not capable of useful abridgment.

On M'Boundon, the Ordeal Poison of the Natives of the Gaboon: New Physiological, Chemical, Histo-Chemical, and Toxicological Researches.—E. Heckel and F. Schlagdenhauffen.—The poison employed contains exclusively one base, strychnine. The authors propose to examine whether the distinction between the tetanising and the paralysing species of the strychnos family may not depend simply on the proportion of the base which they contain.

Specific Magnetism of Ozone.—H. Becquerel.—Ozone being more magnetic than oxygen it is easy to see

that the relation of the specific magnetism of ozone to that of oxygen is notably greater than the supposed relation of their densities. The specific magnetism of ozone is then greater than what would correspond to the quantity of oxygen which it contains.

Electric Phenomena of Tourmaline and of Hemihedral Crystals with Inclined Surfaces.—J. and P. Curie.—The hypothesis which the authors put forward is that there exists a constant difference of tension between the opposite surfaces of two successive layers. Tourmaline being a compound body the different parts of a crystalline molecule may be formed of different substances, which would explain the difference of tension of the opposite extremities of two molecules.

The Compounds of Hydrochloric Acid with Mercuric Chloride.—A. Ditte.—There exists a whole series of compounds of these two substances, several of which the author has isolated and analysed.

Violet Illumination of the Retina under the Influence of Luminous Oscillations.—A. Charpentier.—The author, fixing his eyes immoveably on a sky illuminated by a uniform white light, and moving two fingers of his right hand rapidly and alternately backwards and forwards before them, saw, after a minute, a remarkable change in the uniform aspect of the heavens. There appeared on a white ground a mosaic composed of rather deep violet-purple hexagons, separated from each other by white lines, and forming a very regular design. The oscillations of the fingers should be from 300 to 400 per minute. The author thinks that these hexagons are due to the cones in the fovea and in the yellow spot, and that the white lines are due to their intervals.

Determinations of the Fundamental Coloured Sensations by the Study of the Complementary Colours in the Chromatic Circle (Second Memoir).—A. Rosenstiehl.—The author taking as a basis the equidistance of the colours which form each of the three sections of the chromatic circle, succeeds in proving that there exist three colours, which possess special properties with reference to our sight.

A Glycoside extracted from Common Ivy.—L. Vernet.—The glycoside in question, $C_{64}H_{54}O_{22}$, is resolvable into a non-fermentible sugar, which reduces Fehling's liquid and a neutral body, tasteless, inodorous, dextro-rotatory, and agreeing with the formula $C_{52}H_{44}O_{12}$.

No. 8, February 21, 1881.

The Refrigerating Power of Gases and Vapours.—M. Witz.—This paper does not admit of useful abstraction.

Radiophony.—E. Mercadier.—Radiophonic effects are thermic, not luminous, and are produced by gases alternately heated and cooled, and not by solids or liquids.

Magic Mirrors of Silvered Glass.—L. Laurent.—The author has produced with glass effects similar to those of the Japanese metallic mirrors and those constructed by MM. Bertin and Duboscq.

Pyridic Bases.—Oechsner de Coninck.—A further account of the three bases which the author discovered in the products of the distillation of cinchonine with potassa.

Permanence of Hydrocyanic Acid for a Month in the Bodies of Animals Poisoned with the Pure Acid.—C. Brame.—Hydrocyanic acid, if administered in a sufficient quantity to animals, preserves them perfectly for a month. It remains in the tissues, and especially in those of the stomach for the same time. It appears to combine intimately with the animal tissues. In the Carnivora it is more difficult to extract by distillation than in the Herbivora.

Moniteur Scientifique, Quesneville.
October, 1880.

Certain Ultramarines.—C. Heumann—A. translation from *Liebig's Annalen.*

Société d'Encouragement.—An account of the prizes awarded to M. Camille Vincent and M. Abel Martin for their respective inventions.

New Treatment of Copper Pyrites: Substitution of Sulphur for Coal as Fuel.—X. Rocques.—A notice of the Hollway process and of certain proposed improvements.

Chemical Constitution of Albumen.—Dr A. Danilewsky.—The transformation of albumen into peptones is produced by a hydratation, which in each phase take place at a fixed part of the molecule. The regressive formation of albumen from its peptones is produced by a similar dehydration. When the molecule loses calcium and phosphoric acid the carboxylic groups appear, and give an acid reaction to the groups thus obtained. In certain phases the molecule may lose a portion of sulphur without being destroyed or changing its properties.

New Researches on the Albumens of Milk.—Dr. Danilewsky and P. Radenhausen.—The albumen of milk is a mixture of stroma-albumen, with small quantities of orro-proteine and the synto-protalbes. The lacto-proteine of Millon and Commaille is a mixture of soluble synto-protalbes, of syntogenes, and of peptones, which alone are precipitated by mercuric chloride. The same mixture with small quantities of peptones represents the galactine of Morin.

Assay of Oils.—A hydrometric process.

The Fourth State of Matter: A Refutation.—Dr. J. Puluj.—From the *Chemiker Zeitung.*

Development of the Cadaveric Alkalies (Ptomaines).—MM. Brouardel and Boutmy.—The authors have verified the presence of these poisons in the viscera of persons who had died either from the action of poisons or otherwise. The organs of an individual asphyxiated by carbonic oxide were analysed some hours after death, and found free from poison. On being re-examined eight days afterwards they contained a solid organic base, presenting the general characters of the alkaloids and proving fatal in small doses to frogs and guinea-pigs. The ptomaines are produced in the dead bodies of men and animals, and vary in their nature under circumstances not yet ascertained. They are poisonous in the majority of cases.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 81, September, 1880.

Report presented by M. Troost on behalf of the Committee of the Chemical Arts on the Malleable Nickel of MM. Gaspard and Belle.—The metal is first brought to a state of complete fusion, its surface is freed from all traces of scoriæ, a small quantity of metallic zinc or magnesium is introduced, the whole is stirred up and run. The metal thus added seems to lay hold of all traces of foreign matter derived from the sides of the crucible. Such nickel is ductile and malleable at all temperatures below its point of fusion, and can be welded either with itself or with iron or steel. Plates and wires of iron or steel can thus be coated with nickel.

Report presented by M. de Luynes on behalf of the Committe of Economic Arts on M. Pinchon's Thermic Areometer for the Assay of Oils.—The instrument is a hydrometer containing a thermometer, a construction already known, but the special graduation adopted by M. Pinchon renders it useful in certain cases for detecting the relative purity of oils. For each oil there is a special spindle graduated so that for one and the same oil the indication of the hydrometer is the same as that of the thermometer. When the oil is pure the agreement between the hydrometric and thermometric degrees is maintained in spite of the variations of temperature. If the oil is mixed with other oils of a different nature this agreement ceases, and the deviation

is the greater according to the proportion of the foreign oil added. A hydrometer graduated for olive oil if mixed, *e.g.*, with oils of colza, or of earth-nuts, deviations of from 3° to 13°. Between the temperatures of 15° and 18°, olive oil marking 15° to 18°, colza marks 20·5°, and oils of sesame and earth-nut 13°. At the temperature of 17·5° a mixture of 1 part colza and 3 parts olive oil marks 19°, whilst 1 par of oil of earth-nuts with 3 parts olive oil at 18° marks 17°

Justus Liebig's Annalen der Chemie, Heft 1, 1880.

Communications from the Laboratory of the University of Würzburg.—These consist of a paper by Max Guthzeit on octyl-substituted acetic esters and their compounds, and a dissertation by E. Böcking on two new syntheses of ethyl-methyl-oxyacetic acid.

Mono-biom aceton and the Alcohol of Aceton.—A. Emmerling and R. Wagner.—In this paper the authors describe the preparation of pure mono-brom-aceton, its behaviour with silver oxide and water, and with an aqueous solution of potassium carbonate. They also give an account of the properties of acetol. It is very soluble in water, boils about 100°, and volatilises with watery vapours. Its specific gravity is greater than that of water. Its solutions reduce alkaline copper oxide in the cold, red cuprous oxide being deposited. On oxidation with potassium dichromate and dilute sulphuric acid, it is resolved into 1 mol. acetic acid and 1 mol. carbonic acid.

Action of Ethyl- and Diethyl-amin upon Aceton·—Dr. O. Eppinger.—The author examines, first, the behaviour of ethylamin with aceton, describing ethyl-diacetonamin platinic chloride hydrochlorate, the corresponding platinous salt, ethyl-diacetonamin hydrochlorate, and ethyl-diacetonamin gold chloride hydrochlorate. He finds that ethyl-diacetonamin is decomposed even at common temperatures in the moment of liberation from its salts. Then follow descriptions of ethyl-diacetonamin nitrate, sulphate, oxalate,—neutral and acid—and picrate. Dr. Eppinger then examines the behaviour of diethylamin with aceton.

Investigations on the Alkaloids of Jaborandi Leaves.—Dr. E. Harnack and Dr. H. Meyer.—The authors hold that in these leaves there is present, along with pilocarpine, another base, jaborine.

Behaviour of the Cinchona Bases with Potassium Permanganate.—S. Hoogewerff and W. A. von Dorp.—By the oxidation of the bases, quinine, cinchonine, quinidine, and cinchonidine, under the conditions observed by the authors, they obtained ammonia, carbonic acid, oxalic acid, and a tri-carbopyridic acid.

A Voltaic Element of Aluminium.—F. Woekler.—There is placed in a glass, containing very dilute hydrochloric acid or dilute soda-lye, aluminium foil bent into a roll. Within it is placed an earthen cell containing concentrated nitric acid, into which plunges a smaller roll of aluminium foil. To each foil is soldered a piece of sheet aluminium, which projects through the cover of so-called hard caoutchouc.

Heft 2, 1880.

Communications from the Chemical Institute of the Royal Forest School at Aschaffenburg.—These contributions consist of a paper on the preparation of malonic acid ester, by M. Conrad; a general view of the preparation of the mono- and dialkyl-substituted malonic acids, by the same author; an account of ethyl-malonic acid, by the same author; a memoir on diethyl-malonic acid and diethyl-acetic acid, by the same; a paper on iso-propyl- and ethyl-methyl-malonic acids; iso-propyl- and ethyl-methyl-acetic acids, by M. Conrad and C. A. Bischoff; an account of dioctyl-malonic and dioctyl-acetic acids, by the same authors; an account of allyl- and di-allyl-malonic, allyl- and diallyl-acetic acids, by the same authors; a notice of benzyl-malonic ester and hydrocinnamic acid, hy M. Conrad; and, lastly, a memoir on benzyl-methyl-malonic acid, benzyl-methyl-acetic ester, benzyl-methyl-acetic acid, and the constitution of hitherto known acids, of the composition $C_6H_5.C_n\,H_{2n-2}COOH$.

MEETINGS FOR THE WEEK.

MONDAY, 21st.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. "The Scientific Principles Involved in Electric Lighting," Professor W. G. Adams, F.R.S.
TUESDAY, 22nd.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
WEDNESDAY, 23rd.—Society of Arts, 8. "The Increasing Number of Deaths from Explosions, with an Examination of the Causes," Cornelius Walford.
—— Geological, 8.
THURSDAY, 24th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "The Future Development of Electrical Appliances," Prof. John Perry.
—— Royal Institution, 3. "Ornament," Mr. H. H. Statham.
FRIDAY, 25th.—Royal Institution, 8. "Weather and Health of London," Mr. A. Buchan, 9.
—— Quekett, 8.
—— Society of Arts, 8. "The Tenure and Cultivation of Land in India," Sir George Campbell, K.C.S.I., M.P.
SATURDAY, 25th.—Royal Institution, 3. "American Humourists," Rev. H. R. Haweis.
—— Physical, 3.

TO CORRESPONDENTS.

A. J. S.—The reactions you speak of are worth following up as they may lead to something new.

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SOLAR PHYSICS.

The following Courses of Lectures will be given by Members of the Committee on Solar Physics, appointed by the Lords of the Committee of Council on Education:—

An Introductory Lecture. By Professor STOKES, Sec. R.S. 6th April, 1881.

A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena. By Lieut.-General STRACHEY, R.E., C.S.I., F.R.S. 8th April.

Two Lectures on the Connection between Solar and Terrestrial Phenomena. By Professor BALFOUR STEWART, F.R.S. 27th and 29th April.

Six Lectures on Spectroscopy in Relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S. 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics. By Captain ABNEY, R.E., F.R.S. 25th and 27th May and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

Admission will be by Tickets, which may be obtained, as far as there is room, on application by letter to the Secretary, Science and Art Department, South Kensington, S.W.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works, Manchester.

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Davey, G. W., 8, Hawthorn-terrace, Barking, Essex
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Dobbin, Leonard, Chemical Laboratory, University, Edinburgh
Firby, Alfred, 2, Fallowfield-terrace, Leeds
Gahan, William Patrick, Bishop's Stotford, Herts
Gaskell, Francis, Newnham-lodge, Spring-grove, Isleworth
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Gibson, John, Ph.D., F.R.S.E., 29, Greenhill-gardens, Edinburgh
Graham, C. C., Silwood, Tulse Hill, S.W.
Grenish, Henry George, 20, New-street, Dorset-square, N.W.
Hadock, A., Runcorn Soap and Alkali Co., Limited, Weston, near Runcorn
Hallen, R., Assoc. R.S.M., 12, Route du Landi, St. Denis, Paris
Hollis, Percy Bast, Borax and Alkali Works, Widnes
Holmes, Frederick George, 46, Hill-street, Peckham, S.E.
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Jago, William, F.C.S., School of Science and Art, Brighton
Johnson, Thomas junr., Stock bridge Works, near Sheffield
Jude, K. H., D.Sc., 37, Kempsford-gardens, South Kensington
Lapraik, William, F.C.S., Chemical Laboratory, St. Bartholomew's Hospital
MacIvor, R.W. Emerson, 59, Queen-street, Melbourne
McGowan, George A., 22, East Claremont-street, Edinburgh
Matthews, C. G., F.C.S., St. John's-lodge, Beckenham
Naigamvala, K. D., 35, Malabar Hill, Bombay
Nelson, Cuthbert Gordon, Royal Veterinary College, N.W.
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Paterson, W. G. Spence, 21, Pitt-street, Edinburgh
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Walker, Henry Herbert, 341, Glossop-road, Sheffield.
Williams, P. Caradoc, 6, Parliament-place, Liverpool

Members are requested to send notice of change of address, &c., to the Secretary, Mr. Charles E. Groves, Somerset-house-terrace, W.C.

SOCIETY FOR THE ADVANCEMENT OF CHEMICAL INDUSTRY.

A Meeting, for the purpose of forming a Society for the Advancement of Chemical Industry, will be held on Monday, April 4th, 1881, in the rooms of the Chemical Society, Burlington House, Piccadilly, London, W., at 4 p.m.

Prof. ROSCOE, F.R.S., President of the Chemical Society, will occupy the chair.

All persons interested in the Chemical Industries are hereby invited to attend.

GEORGE E. DAVIS, Hon. Sec. *pro tem.*

AMMONIACAL LIQUOR.

THE DIRECTORS OF THE BRISTOL UNITED GAS LIGHT COMPANY invite TENDERS for the PURCHASE of the AMMONIACAL LIQUOR made at all or either of their THREE STATIONS, situate respectively at AVON STREET, CANONS' MARSH, and STAPLETON ROAD in the Borough of Bristol, for a TERM of FIVE or SEVEN YEARS, commencing on 1st JULY, 1882.

The Annual Quantity of Liquor produced at present at the three Stations is about 2¼ millions of gallons.

Conditions of Contract and other particulars may be obtained of the SECRETARY, at the Office of the Company, Canon's Marsh, Bristol.

Tenders to be delivered on or before TUESDAY, 3rd day of May next, addressed to the Chairman of the Company, and marked 'Tender for Ammoniacal Liquor."

The Directors do not bind themselves to accept the highest or any Tender.

HENRY H. TOWNSEND, Secretary.

Gas Offices, Canons' Marsh, Bristol,
8th January, 1881.

THE CHEMICAL NEWS.

Vol. XLIII. No. 1113.

ON THE CALORIFIC POWER OF FUEL, AND ON THOMPSON'S CALORIMETER.

By J. W. THOMAS, F.C.S., F.I.C.

A simple experiment, capable of yielding results which shall be at least comparative, has long been sought after by large consumers of coal and artificial fuel abroad in order to ascertain the relative calorific power possessed by each description, as it is well known that the proportion of mineral matter and the chemical composition of coal differs widely. The determination of the ash in coal is not a highly scientific operation; hence it is not surprising that foreign merchants should have become alive to the importance of estimating its quantity. While, however, the nature and quantity of the ash can be determined without much difficulty, the determination of the chemical composition of coal entails considerable labour and skill; hence a method giving the calorific power of any fuel in an exact and reliable manner by a simple experiment is a great desideratum. This will become more obvious when one takes into consideration the many qualities and variable characters of the coals yielded by the South Wales and North of England coal fields. Bituminous coals—giving some 65 per cent of coke—are preferred for some manufacturing purposes, and in some markets. Bituminous steam coals, yielding 75 per cent of coke, are highly prized in others. Semi-bituminous steam coals, yielding 80 to 83 per cent of coke, are most highly valued, and find the readiest sale abroad; and anthracite steam coal (dry coals), giving from 85 to 88 per cent of coke (using the term "coke" as equivalent to the non-volatile portion of the coal) is also exported in considerable quantity. Now the estimation of the ash of any of these varieties of coal would afford no evidence as to the class to which that coal belongs, and there is no simple test that will give the calorific power of a coal, and at the same time indicate the degree of bituminous or anthracitic character which it possesses. In order to obtain such information it is necessary that the percentage of coke be determined together with the sulphur, ash, and water, and these form data which at once show the nature of a fuel and give some indication of its value. To ascertain the quantity of the sulphur, ash, and water with accuracy involves more skill and aptitude than can be bestowed by the non-professional public; the consequence is that experiments entailing less time and precision, like those devised by Berthier and Thompson, have been tried more or less extensively. In France and Italy, Berthier's method—slightly modified in some instances—has been long used. It is as follows:—

70 grms. of oxide of lead (litharge) and 10 grms. of oxychloride of lead are employed to afford oxygen for the combustion of 1 grm. of fuel in a crucible. From the weight of the button of lead, and taking 8080 units as the equivalent of carbon, the total heat-units of the fuel is calculated. This experiment is very imperfect and erroneous upon scientific grounds, since the hydrogen of the fuel is scarcely taken into account at all. In the first place, hydrogen consumes only one-quarter as much oxygen as carbon, and, furthermore, two-ninths only of the heating power of hydrogen is used as the multiplying number, viz., 8080, whilst the value of hydrogen is 34,462. In other words, one-eighteenth only of the available hydrogen present in the fuel is shown in the result obtained. Apart from this my experience of the working of Berthier's method has been by no means satisfactory. There is considerable difficulty in obtaining pure litharge, and it is almost impossible to procure a crucible which does not exert a reducing action upon the lead oxide. Some twelve months ago I went out to Italy to test a large number of cargoes of coal with Thompson's calorimeter, and since then this apparatus has superseded Berthier's process, and is likely to come into more general use. Like Berthier's method, Thompson's apparatus is not without its disadvantages, and the purpose of this paper is to set these forth, as well as to suggest an uniform method of working by means of which the great and irreconcilable differences in the results obtained by some chemists might be overcome. It has already been observed that a coal rich in hydrogen shows a low heating power by Berthier's method, and it will become evident on further reflection that the higher the percentage of carbon the greater will be the indicated calorific power. In fact a good sample of anthracite will give higher results than any other class of coal by Berthier's process. With Thompson's calorimeter the reverse is the case, as the whole of the heating power of the hydrogen is taken into account. In short, with careful working, the more bituminous a coal is the more certain is it that its full heating power shall be exerted and recorded, so far as the apparatus is capable of indicating it; for when the result obtained is multiplied by the equivalent of the latent heat of steam the product is always below the theoretical heat units calculated from the chemical composition of the coal by the aid of Favre and Silbermann's figures for carbon and hydrogen. On the other hand, when the heating power of coal low in hydrogen is determined by Thompson's calorimeter, much difficulty is experienced in burning the carbon completely; hence a low result is obtained. From a large number of experiments I have found that when a coal does not yield more than 86 per cent of coke, it gives its full comparative heating power, but it is very questionable if equal results will be worked out if the coke exceeds the above amount, although I have met with coals giving 87 per cent of coke, which were perfectly manageable, though in other cases the coal did not burn completely. It will be noted that the non-volatile residue of anthracite is never as low as 86 per cent, and this, together with the very dry steam coals and bastard anthracite (found over a not inextensive tract of the South Wales Coal Field), form a series of coals, alike difficult to burn in Thompson's calorimeter. Considerable experience has shown that in no single instance was the true comparative heating power of anthracite or bastard anthracite indicated. With a view to accelerate the perfect combustion of these coals, sugar, starch, bitumen, and bituminous coals—substances rich in hydrogen—were employed, mixed in varying proportions with the anthracitic coal, but without the anticipated effect. Coke was also treated in a like manner. Without enlarging further upon these futile trials—all carefully and repeatedly verified—the results of my experiments and experience show that for coals of an anthracitic character, yielding more than 87 per cent of coke, or for coke itself, Thompson's calorimeter is not suited as an indicator of their comparative calorific power for the simple reason that some of the carbon is so graphitic in its nature that it will not burn perfectly when mixed with nitrate and chlorate of potash. A sample of very pure anthracite used in the experiments referred to, gave 90·4 per cent of non-volatile residue, and only 0·84 per cent of ash. This coal was not difficult to experiment with, as combustion started with comparative ease and proceeded quite rapidly enough, but in every instance a portion of the carbon was unconsumed, and consequently instead of about 13° of rise in temperature only 10° were recorded.

Since the calorific power of a coal is determined by the number of degrees Fahrenheit which a given quantity of water is raised in temperature by a known weight of fuel, it follows that every care should be taken that the experiment be performed under similar atmospheric conditions. The oscillation of barometric pressure does not appear to affect the working, but the temperature of the room in

which the work is done, and especially that of the water, are most important considerations. It has been observed by some who have used this apparatus—and I have frequently noticed it myself—that the lower the temperature of the water is under which the fuel is burnt the higher is the result found. This has been explained on the assumption that the colder the water used, the greater is the difference between the temperature of the room and that of the water; hence it would be expedient that in all cases when such experiments are made the same difference of temperature between the air in the room and the water employed should always exist. For example, if the temperature of the room were 70°, and the water at 60°, then the same coal would give a like result with the water at 40° and the room at 50°. This has been regarded as the more evident, because the gases passing through the water escape under favourable conditions of working at the same temperature as the water, and are perfectly deprived of any heat in excess of that possessed by the water. Under these circumstances it would seem only reasonable that this assumption should be correct. It was, however, found after a large number of experiments upon the same sample of coal that this was not the case. 30 grs. of coal which rises the temperature of the water 13·4°, when the water at starting was 60° and the room at 70°, gives 13·7° rise of temperature with the water at 40° and the room at 50°. Conversely, when the water is at 70° and the room at 80°, a lower result is obtained. The explanation appears to be this:—The gas which escapes from the water was not in existence in the gaseous form previous to the experiment, and the heat communicated to the gas being a definite quantity it follows that the more the gas is cooled the greater the proportion of chemical energy in the shape of heat will be utilised and recorded as calorific power.

In order, therefore, to make the experiment more simple and workable at all temperatures, a sample of coal was selected, which should be perfectly manageable and readily consumed. Appended is an analysis of the coal employed (from Ebbw Vale, Monmouthshire):—

	Composition per cent.
Carbon	88·33
Hydrogen	5·08
Oxygen	3·28
Nitrogen	0·55
Sulphur	0·70
Ash	1·26
Water (moisture)	0·80
	100·00

In the following experiments the standard temperature of the water was taken as 60° F., and as the coal gave 13·4° of rise of temperature, 67°F. was selected as the standard room temperature. The reason for this room temperature is obvious, for, whatever heating effect the higher temperature of the room may have upon the water in the cylinder during the time occupied by the first half of the experiment, would be compensated for by the loss sustained during the second half of the experiment, when the temperature of the water exceeded that of the room. The mean of numerous trials gave 13·4° F. rise of temperature, equal to 14·74 lbs. of water per lb. of coal. When the water was at 50° and the room at 57°, the mean of several experiments gave 13·5° rise of temperature. When the water was 40° at starting and the room at 47°, 13·65° was the average rise of temperature. Trials were made at intermediate temperatures, and the results always showed that higher figures were recorded when the water was coldest. With a view of getting uniformity in the results it was thought well to make experiments, in order to find out what temperature the room should be at, so that this coal might give the same result with the water at 50°, 40°, or at intermediate temperatures. Without going much into detail, it was found that when the temperature of the room was at 40° and that of the water 40°, and the experiment was rapidly and carefully performed, 13·4° rise of temperature was given; but this result could be obtained without special effort when the room was 42° and the water 40° at starting. It is evident that the cooling effect of the air in the room upon the water cylinder is very appreciable when the water has reached 13° above that of the room. When the water was at 50° and the room at 55°, the coal gave 13·4° rise with ease and certainty, and it would not be out of place to remark here that with those coals which burn well in Thompson's calorimeter, the results of several trials are remarkably uniform when properly performed. With the water at 70° and the room at 80°, a like result was worked out. Experiments at intermediate temperatures were also carried out (see table in sequel). It is true that the whole difference of temperature we are dealing with in making these corrections is only 0·25, but 0·2 in the result, when multiplied by 537 to bring it into calories, as is done by the authorities in Italy, makes more than 100 heat units—a serious difference when 5d. per ton fine is attached to every 100 calories lower than the number guaranteed.

Taking the latent heat of steam as 537° C., and multiplying this number by 14·74, the evaporative power of the coal used in these experiments, its equivalent in calories is 7915. From the analysis of this coal, disregarding the nitrogen and deducting an equivalent of hydrogen for the oxygen present, the *total heat units* given by Favre and Silbermann's figures for carbon (8080) and hydrogen (34,462) will be 8746. It will be seen, therefore, that the calorific power, as determined by Thompson's apparatus, gives a much lower result when multiplied by 537 than the heat units calculated from the chemical composition of the coal. When I used Thompson's apparatus in the chemical laboratory at Turin to determine the evaporative power of various cargoes of South Wales coal, it was agreed by mutual consent that the temperature of the water at starting should be 39° F. (the temperature at which the *heat unit* was determined). The temperature of the room was about 60°, but this varied, as the weather was somewhat severe and changeable. Under these conditions with the water at 39° and room 60°, the coal which gives 14·74 lbs. of water per lb. of coal, will give as high as 15·88 lbs. of water per lb. of coal. This result multiplied by 537 = 8496 calories, approaching much more nearly to the theoretic value. This method of working is still practised abroad, but experience has shown that very widely differing results follow when working in this manner, especially if the temperature of the room is changeable, as it naturally is where ash determinations and other chemical work is proceeding simultaneously. The time the experiment lasts, taking the reading on a quickly rising thermometer and other considerations, render the experiments anything but trustworthy when 0·2 of a degree makes a difference of more than 100 calories. In the instructions supplied with Thompson's calorimeter nothing is said as to the temperature of the room in which the experiment is performed, but simply that the water shall be at 60° F. If, with the water at 60°, a room were at 50°, as it often is in winter, a good coal would give 14 lbs. of water per lb. of coal as the evaporative power; but if in summer, the room were at 75° and the water at 60°, the same coal would give 15 lbs. of water per lb. of coal. If further evidence were needed of the effect of temperature a consideration of the experiments already referred to will show how necessary it is that some general rule shall be adopted. Considerable stress is laid (in the instructions) upon the quantity of oxygen mixture used being determined by rough experiments. This I have found leads to erroneous conclusions unless a number of experiments are tried in the calorimeter, as it often happens that the quantity which appears to be best adapted is not that which yields a trustworthy result. There are many samples of South Wales coal, 30 grains of which will require 10 parts of oxygen mixture in order to burn completely, but since a little oxygen is lost in drying and grinding and few samples of chlorate are free from chloride, it is not safe to use less than 11 parts of oxygen

mixture, but this amount is sufficient in *all* cases, and never need be exceeded. I have made numerous experiments with various coals (anthracite, steam, semi-bituminous, and bituminous, including a specimen of the ten yard coal of Derbyshire), and find that with 11 parts of chlorate and nitrate of potash, they are all perfectly manageable and yield the best results. It is quite clear that the excess of chlorate is decomposed in all instances, and the latent heat of the oxygen evolved, but those coals which are best to experiment with did not yield results that differed when the quantity of oxygen mixture was reduced to nearly the limit required for combustion of the coal. Under these circumstances, therefore, the constant use of 11 parts of oxygen mixture—a suitable quantity for all coals exported—would enable operators to obtain similar figures, and make the test uniform in different hands.

The following is a brief outline of the method of procedure recommended:—Sample the coal until an average portion passes through a sieve having 64 meshes to the square inch. Take about 300 grains (20 grms.) of this and run through a brass wire gauze having 4600 meshes to the square inch, taking care that the whole sample selected is thus treated. One part of nitrate of potash and 3 parts of chlorate of potash (dry) are separately ground in a mortar, and repeatedly sifted through another wire gauze sieve, having 1000 meshes to the square inch, in order that the oxygen mixture shall *not* be ground to an impalpable powder, as this is very undesirable. It absorbs moisture rapidly, and interferes with the regularity of the combustion when very fine. 330 grains of the powder are weighed out (after drying), and intimately incorporated with 30 grains of coal—better with a spatula than by rubbing in a mortar—and then introduced into a copper cylinder (3½ ins. long by ¾ in. wide, made from a copper tube), and pressed down in small portions by a test-tube with such firmness as is required by the nature of the coal, not tapped on the bottom, since the rougher portions of the oxygen mixture rise to the surface. As the temperature of a room is almost invariably much higher than the water supply, a little hot water is added to that placed in the glass cylinder, until the difference of temperature between the water and the room is about the mark indicated in the following table:—

Room at	The Water should be
80° F.	70° F.
72	64
67	60
60	54
55	50
50	46
42	40

Say, for example, the room was at 57° and the water placed in the cylinder was at 46°: add a little hot water and stir with the thermometer until it assumes 52°. By the time the excess of water has been removed with a pipette until it is exactly level with the mark, and all is ready, the temperature will rise nearly 0·5°. Let the thermometer be immersed in the water at least three minutes before reading. The fuse should be placed in the mixture, and everything at hand before reading and removing the thermometer. After igniting the fuse and immersing the copper cylinder in the water, the apparatus should be kept in the best position for the gases to be evolved all around the cylinder, and the rate of combustion noted. Some coals are very unmanageable without practice, and samples of "Patent Fuel" are sometimes met with, containing unreasonable proportions of pitch, which require some caution in working and very close packing, inasmuch as small explosions occur during which a little of the fuel escapes combustion.

In order that the experiment shall succeed well, experience has shown that the nature of the fuse employed has much to do with it. Plaited or woven wick is not adapted, and will fail absolutely with dry coals, unless it is made very free burning. In this case not less than three-quarters of an inch in length is necessary, and the weight of such is very appreciable. I always use Oxford cotton, and thoroughly soak it in a moderately strong solution of nitrate of potash. When dry it should burn a little too fast. The cotton is rubbed between two pieces of cloth until it burns just freely enough; then four cotton strands are taken, twisted together, and cut into lengths of ¾ in. and thoroughly dried. Open out the fuse at the lower end when placing it in the mixture so as to expose as much surface as possible in order to get a quick start, but carefully avoid pressing the material, and use a wire to fill up close to the fuse A slow start often spoils the experiment, through the upper end of the cylinder becoming nearly filled up with potassic chloride, &c.

By paying attention to such details, and following the method recommended, the apparatus yields very satisfactory results with bituminous and semi-bituminous coals.

The Laboratory, Cardiff,
March 8, 1881.

ON DETERMINATIONS OF AMMONIA IN WATER ANALYSIS.

By WILLIAM HENRY WATSON, F.C.S.

WHEN examining waters by the ammonia process it is frequently requisite, owing to the presence of suspended matters in the samples, to filter the water previous to distillation, and it therefore occurred to me to determine whether the amount of ammonia, usually described as "free" ammonia, is noticeably affected by this procedure. Naturally we might expect to find the simple removal of suspended matters to affect only that portion of the ammonia given off after treatment with alkaline solution of potassium permanganate, but I have found in several instances the amount of free ammonia to be considerably lessened also. The following results were obtained:—

1. Sample of water containing 4·26 grs. of flocculent suspended matter per gallon, of which 3·18 remain after ignition.

	Parts per Million.
Free ammonia before being filtered.. ..	0·430
,, ,, after ,, ,, ...	0·370
,, ,, removed by filtration ..	0·060

2. Sample of water containing 3·05 grs. of suspended matter of which 1·50 remain after ignition.

Free ammonia before filtering..	0·318
,, ,, after ,, ...	0·250
Difference	0·068

In the instance of waters in which there was no suspended matter, I have not found any appreciable diminution in the amount of free ammonia by filtration. It is therefore evident that the suspended matter removed by filtration, as in the experiments quoted, carries some of the ammonia absorbed in its substance.

A fresh series of experiments was made by infusing pieces of fresh beef in water, and by keeping the infusion for several days until decomposition had begun. A flocculent substance, after six days' standing, was formed in the infusion, after which the ammonia determinations were made before and after filtering, with the following results:—

	Parts per 1000.	
	Before.	After.
Experiment 1...	0·050	0·038
,, 2...	0·048	0·038
,, 3...	0·053	0·040

No doubt the proportion of ammonia in this way absorbed from water and capable of being removed with suspended matter, depends upon the nature of the suspended matter both chemically and physically. However, it would ap-

pear desirable to make it a rule that, in waters containing matters in suspension, separate quantities of water should be taken for the determinations of "free" and "albumenoid" ammonia respectively. Thus the original unfiltered water should be employed for free ammonia, while the water previously filtered should be taken for the albumenoid ammonia; no note being necessary of the free ammonia in the latter case.

Analytical Laboratory, The Folds, Bolton.

ON THE ANALYSIS OF BISULPHIDE OF CARBON.

By H. MACAGNO.

When carbon disulphide is gradually added to a solution of potash in absolute alcohol, potassium xanthate is formed, according to the following equation:—

$$C_2H_5HO + KHO + CS_2 = KC_2H_5COS_2 + H_2O.$$

This alcoholic solution, saturated with acetic acid, and treated with a drop of cupric sulphate, gives a brownish precipitate of cupric xanthate, which quickly changes to bright yellow flocks of cuprous xanthate. This salt is insoluble in water, and in dilute acids.

The formation of cuprous xanthate has been employed for detecting carbon disulphide in coal-gas, the gas being passed through alcoholic potash. The same reaction, I think, could be very useful to analyse commercial disulphide of carbon or in estimating the quantity of this compound in soil air, when it is employed as a remedy for the *phylloxera*. To the end of obtaining a quantitative method, I endeavoured to determine in cuprous xanthate the quantity of copper, corresponding to carbon disulphide employed.

Four assays on 100 c.c. of an alcoholic solution, containing 1 grm. of carbon disulphide per litre, give me the following quantity of cupric oxide (CuO), burnt in a platinum crucible:—

0·0526 grm.
0·0520 ,,
0·0516 ,,
0·0512 ,,

Mean result, CuO = 0·0518 grm. for 0·10 grm. disulphide.

Very troublesome would be analysis in this way, for which much time and many delicate manipulations are requisite. For it, I undertook some researches on a volumetric process.

A drop of potassium ferrocyanide spread on a clean white plate and touched by a small glass rod, moistened with neutral and alcoholic solution of potassium xanthate, gives a perfectly white compound: but if xanthic acid has been precipitated as cuprous xanthate, and a slight amount of cupric sulphate is present, the ferrocyanide drop becomes red-brown, for the well-known precipitate of cupric salts is produced.

This fact suggests a simple means of determining the whole of the xanthic acid, by decinormal solution of copper, that we can easily prepare by dissolving in a litre of water 12·47 grms. of crystallised cupric sulphate, previously powdered and pressed between blotting-paper. By this method I obtained the following results:—

Carbon Disulphide mixed with Alcoholic Potash Solution. Grm.	Decinormal Solution of Cupric Sulphate. C.c.
0·10	13·2
0·15	19·7
0·20	26·2
0·15	19·8
0·10	13·1
0·30	39·5
1·00	131·5

And from it we deduce that:—

To 1 c.c. of $\frac{n}{10}$ copper solution corresponds 0·0076 grm. of carbon disulphide, viz., $\frac{1}{1000}$th of its molecular weight.

I think this process would render no little service in commercial analysis of carbon disulphide, in order to discover its adulterations with other liquids, and also when we have to estimate the amount of its vapour in gaseous compounds.

Agricultural Station of Palermo, Italy,
February, 1881.

THE ALKALOID FROM PITURIE.*

By Professor LIVERSIDGE, Assoc. R. S. Mines, F.I.C.

(Concluded from p. 126).

Reactions of the Alkaloid.

Neither concentrated hydrochloric acid nor nitric acid changes the colour of the alkaloid in the cold, but when warmed, hydrochloric acid imparts a slightly reddish colour, and nitric acid turns it yellow. Concentrated sulphuric acid turns it brown after some time, immediately when warmed.

Platinic chloride does not precipitate an aqueous solution of the alkaloid (1 : 100 aq) so long as the alkaloid is in excess, but when the solution has become neutralised, the addition of another drop of platinic chloride throws down a slight yellowish flocculent precipitate, which dissolves on heating, but does not reappear on cooling; if a larger quantity of the platinic chloride be added, the precipitate still dissolves on the application of heat, but on cooling reappears in a crystalline condition.

In a solution of 1 part of the hydrochloride of the alkaloid to 50 of water, a precipitate similar to the above is thrown down, and if heated, a part re-dissolves, the undissolved portion turns to an orange-yellow colour and becomes crystalline—the dissolved salt also crystallises only on cooling. Under the microscope the crystals appear to have the form of the octahedron, or combinations of that with other forms belonging to the cubical system. More dilute solutions of the hydrochloride are not precipitated by platinic chloride.

All the following tests were made with an aqueous solution of 1 part of the alkaloid to 100 water.

Mercuric chloride, in the aqueous solution of the alkaloid, throws down a white cheesy precipitate, insoluble in an excess of the precipitant, easily soluble in hydrochloric acid; on heating to boiling the precipitate softens, but does not actually melt; it is difficultly soluble in boiling water; on cooling it is re-deposited in an amorphous state.

A few drops of *mercuric chloride* give a white precipitate in a solution of the hydrochloride, which disappears on shaking, but when the mercuric chloride is in excess, a white crystalline precipitate is thrown down, which is rather easily soluble in hot water; on cooling, crystals in the form of rhombic prisms and plates are deposited, soluble in hydrochloric acid.

Copper sulphate in an aqueous solution of the alkaloid gives a light green precipitate, insoluble in an excess of the alkaloid. In a solution of the hydrochloride the copper sulphate does not produce any change.

A few drops of *gold chloride* added to the aqueous solution give a reddish-white precipitate, which disappears on shaking; a larger quantity of the reagent gives a flocculent reddish-white precipitate, which is persistent, soluble in hydrochloric acid with difficulty.

In the solution of the hydrochloride a few drops of gold chloride give a reddish-white precipitate, which re-dissolves on agitation; a larger quantity of the reagent gives a

* A Paper read before the Royal Society of New South Wales November 3, 1880.

reddish precipitate, which is permanent but easily soluble in hydrochloric acid, much more so than the precipitate from the alkaloid.

Tannic acid gives a greyish-white precipitate in the aqueous solution—easily soluble in hydrochloric acid. In the neutral solution of the hydrochloride there is a greyish-white turbidity only, which disappears on the addition of hydrochloric acid.

The double iodide of mercury and potassium ($HgI_2,2KI$) gives a heavy white crystalline precipitate in the aqueous solution. Under the microscope this is seen to be made up of small plates arranged in stellate groups. With hydrochloric acid the precipitate becomes yellow and pasty, but does not dissolve in the cold, readily soluble on heating; on cooling the solution becomes turbid.

In the solution of the hydrochloride $HgI_2,2KI$ gives a heavy amorphous yellowish white precipitate; on the addition of a little hydrochloric acid it becomes pasty; on heating a part dissolves; with a larger quantity of hydrochloric acid, the whole dissolves on heating; on cooling it is re-deposited as a yellow amorphous powder.

On the addition of a small quantity of an alcoholic solution of iodine a yellowish turbidity only is imparted to the solution, which is persistent for some hours; but a greater quantity produces a brown precipitate.

On treating the alkaloid with concentrated sulphuric acid and a trace of potassium bichromate in powder, the fluid takes the colour of the bichromate; after a time it changes to a dirty brown and then to green. When warm the change of colour takes place immediately.

With manganese peroxide (MnO_2) instead of the bichromate, no change takes place in the cold; when warm a faint violet colour is produced.

The alkaloid behaves very like nicotine with picric, phospho-molybdic, and metatungstic acids; the addition of picric acid throws down a yellow precipitate soluble in hydrochloric acid.

Phospho-molybdic acid forms a yellowish white amorphous precipitate, insoluble in cold dilute hydrochloric acid, easily and completely dissolved on warming.

The precipitate with nicotine is a dirty yellowish white amorphous, insoluble in cold dilute hydrochloric acid, soluble when warmed, but apparently not so readily as is the precipitate from the piturie alkaloid, some white flakes being left undissolved.

Metatungstate of sodium forms with both piturine and nicotine a white amorphous precipitate, soluble only in much dilute hydrochloric acid when warmed.

Iodine.—When iodine dissolved in ether is added to an etherial solution of the alkaloid the fluid becomes brownish-red and turbid; after a short time yellowish red needles are deposited, the mother-liquor being yellow: these crystals are easily soluble in alcohol, yielding a brownish-red solution; when the alcoholic solution is evaporated at the ordinary temperature, indistinct needles and oily drops are left behind.

When this alcoholic solution is treated with caustic soda in the cold, a smell similar to that of iodoform is emitted, not that of the alkaloid; from the nicotine compound nicotine is liberated, according to Wertheim (Watts's "Dictionary of Chemistry," iv., p. 47).

The iodine compound of piturine melts at about 110° C., that of nicotine at 100° C. (Watts's "Dictionary of Chemistry," iv., p. 47).

Differences.

From coneine it is distinguished by its aqueous solution not becoming turbid on heating nor by the addition of chlorine water. It differs from aniline by not being coloured by chloride of lime; it differs from picoline in specific gravity (picoline being only 0·9613 at 0° C.); from pyridine by its reaction with copper sulphate, the precipitate $Cu(OH)_2$ produced by pyridine with copper sulphate re-dissolves in an excess of the precipitant; and it appears to be distinguished from nicotine by its reactions with platinic chloride, gold chloride, iodine and mercuric chloride also by Palm's test. According to Palm (*Russische Zeitschrift für Pharmacie*, i., 4, and *Husemann's Pflanzenstoffe*), nicotine when gently warmed with a little hydrochloric acid of 1·12 specific gravity turns violet, and on the addition of a little strong nitric acid the colour changes to a deep orange—the only sample of nicotine to be obtained in Sydney yielded the latter part of the above test very well; the orange being very stable, the violet colour was not so well marked. The piturine does not change colour at all, but when more heat is applied it becomes yellow.

The Composition of the Alkaloid.

To determine the composition of the alkaloid, the carbon and hydrogen were estimated in the usual way by combustion with lead chromate, the nitrogen by the soda-lime process; the ammonium chloride left after the evaporation of the excess of hydrochloric acid was titrated with decinormal solution of silver nitrate.

The alkaloid for the determination of the carbon, hydrogen, and nitrogen was taken from two different specimens prepared from two different supplies of the piturie, but in both cases the boiling-points were the same, viz., 243° to 244° C.

To prevent oxidation, the alkaloid was enclosed in the combustion bulbs immediately after its preparation.

The results obtained were as follows:—

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Carbon	76 63	76·64	—	—	lost	76·53	—	76·46
Hydrogen	8·49	8·46	—	—	8·52	8·51	—	8·41
Nitrogen	—	—	14·80	15·00	—	—	15·01	—

The average of these eight analyses is—

Carbon	76·56
Hydrogen	8·48
Nitrogen	14·94

And the relative proportions when calculated in the usual way are—

Carbon	5·98
Hydrogen	7·96
Nitrogen	1·00

or very nearly 6 : 8 : 1.

The formula would therefore be C_6H_8N, which requires—

	Theory.	Found.
$C_6 = 72$	76·59 per cent	76 56 per cent.
$H_8 = 8$	8·51 ,,	8·48 ,,
$N = 14$	14·90 ,,	14·94 ,,
94	100 00	99·98

To confirm this formula a platinum double salt was prepared in the usual manner. The crystals so obtained were orange red octahedra fairly soluble in warm water, but very easily soluble when even a trace of the free alkaloid is present; partly soluble in alcohol, but insoluble in ether.

To ensure as far as possible uniformity of composition, the platinum salts were always prepared from the same portion of alkaloid with the same solution of platinic chloride, and as much as possible under the same circumstances; notwithstanding this the percentages of platinum and of chlorine obtained were never the same, for the salts prepared at different times, neither did they fit in or correspond with the above-mentioned formula. The amount of chlorine was too small for the usual proportion of 1 Pt to 6 Cl met with in the normal double salts of platinum; in some cases it was even less than 1 : 5.

The amount of platinum was determined in twenty-three cases upon salts prepared at ten different times, but from the same substance and with the same platinic chloride; the amount of Pt varied from 34·15 per cent to 38·40 per cent; seven analyses yielded between 35·35 and 35·55 per cent Pt. Nine determinations of chlorine were made, and they varied from 31·32 to 36·86 per cent Cl.

The platinum salt is therefore clearly not of uniform composition or else very unstable; it undergoes decomposition with loss of chlorine during evaporation, even when conducted under the desiccator without the aid of heat.

The mercuric-chloride double salt, prepared by adding an excess of saturated solution of mercuric-chloride to a solution of the hydrochloride of the alkaloid, crystallised well in rhombic plates and prisms; the double salt was crystallised from boiling water, dried at 100° C., and the amount of mercury and chlorine determined in it.

Two analyses gave—

	I.	II.	Mean.
Mercury ..	63·26 per cent	63·09 =	63·175
Chlorine ..	24·60 ,,	24·64 =	24·620

The mean results calculated in the usual manner come to 1·00 Hg : 2·1955 Cl, or 5 Hg : 10·9775 Cl, or very nearly 5 Hg : 11 Cl, which would fit to the formula—

$$(C_6H_8N)_2HCl+5HgC_2,$$

which requires 63·31 per cent Hg and 24·72 per cent Cl, while the corresponding compound of nicotine,

$$C_{10}H_{14}N_2,HCl+5HgCl_2,$$

would require 64·37 per cent Hg and 25·15 per cent Cl.

Besides, nicotine is said to form under the same circumstances a double salt containing 4 $HgCl_2$ instead of 5 molecules of $HgCl_2$. (*Vide* Watts's "Dictionary of Chemistry," iv., 47.

The above two analyses appear to make it probable that the true formula of the alkaloid is $(C_6H_8N)_2$ or $C_{12}H_{16}N_2$, *i.e.*, double that yielded by its ultimate analysis, but much importance cannot of course be attached to such a compound as $(C_6H_8N)_2HCl+5HgCl_2$, in which the amount of alkaloid present is so very small.

Alkalimetric Power.

0·2986 grm. of the alkaloid required 18·5 c.c. 1-10th normal sulphuric acid, a corresponding amount to that required by nicotine, to form $(C_{10}H_{14}N_2)_2H_2SO_4$; the molecular weight of nicotine being 162, $0·0162\times18·5=0·2997$ instead of 0·2986.

I hope at some future period to continue the subject of this paper; meanwhile my best thanks and acknowledgments are due to my assistant, Dr. Helms, now Assistant Demonstrator in the University Laboratory, for his very valuable help in carrying out the details of this investigation.

Note. The name of this substance has been spelt in many different ways, such as, "pitchiry," "picherie," "pedgery," "bedgery," and "pitury"; the most usual spelling at present is "pituri." To show that the final "i" in pituri is not to be pronounced as "i" in *pine* I have spelt the word "piturie."

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 17th, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The minutes of the previous meeting were read and confirmed. The following certificates were read for the first time:—A. J. Anderson, B. Browning, T. R. Ord, G. C. Robinson, W. R. Smith. During the evening the following gentlemen were ballotted for, and declared duly elected Fellows of the Society (the Scrutators were Dr. Japp and Mr. J. Spiller):—W. E. Adeney, H. Borras, J. F. Braga, T. C. Day, R. A. Edgell, E. I. G. Gill, M. Hiddingh, O. B. Mills, O. V. Piscari, L. F. O'Shea, F. Tiemann, G. Valentine, A. Walker.

The following papers were read:—

"*On the Volume of Mixed Liquids*," by F. D. Brown. The author was led to make the experiments recorded in his paper by the necessity of ascertaining with perfect certainty and tolerable facility the composition of any given mixture of two liquids. This necessity arose in some other researches in which the author was engaged. He determined to make use of density as the most readily accessible property. On mixing several liquids in pairs he found that in most cases a considerable expansion took place, in a few cases a contraction, whilst in only one case did the volume remain unaltered. Similar facts had been observed by MM. Bussy and Buignet. The author proceeded to measure these changes of volumes with great exactness. Special precautions were taken regarding the temperature, the volume, and the weight of the liquid. A carefully prepared thermometer was very carefully used. The tubes used for containing the liquid were of the form suggested by Dr. Sprengel. The mixtures first tried were carbon disulphide and benzene, carbon disulphide and carbon tetrachloride, carbon tetrachloride and benzene. Curves and tables are given representing the difference between the observed and calculated volumes. These liquids had no apparent action on each other; the first two pairs expanded considerably, the third slightly contracted. The author thought that perhaps liquids having the same boiling-point might mix without change of volume: this hypothesis was found to be false in the case of dichlor-ethane, boiling-point 84°, and benzene, boiling-point 80°. Similarly the idea that substances whose molecular volumes were the same would mix without change of volume was proved to be untrue in the case of dibrom-ethane, molecular volume 88·6, and benzine, molecular volume 86 6, which substances expand when mixed. Finally, the author was led to the conclusion that these changes of volume are dependent on the chemical character of the molecules, and are entirely independent of such physical properties as the vapour tension, molecular volume, &c., similar curves being obtained with mixtures of carbon tetrachloride and benzene and carbon tetrachloride and toluene. All the above experiments were made at 20° C. From the experiments of Mendeljeff, and Dupré and Page, it would seem that the change of volume would be less marked at higher temperatures.

Prof. McLeod asked if in every case, whether expansion or contraction took place, heat was evolved on mixing.

Dr. Debus asked whether, at the point of maximum expansion of a mixture, the proportion of liquids in that mixture indicated a simple molecular relation, and whether expansion was always accompanied by absorption and contraction by liberation of heat.

Mr. Brown said that it was very difficult to say, as the curve was nearly horizontal, where the point of maximum expansion really occurred, but in the case of alcohol and water the greatest contraction seemed to take place when 1 molecule of alcohol was mixed with 3 molecules of water. Expansion was not always accompanied by absorption of heat.

The next paper was read by Mr. R. Cowper, "*On the Action of Alcohol on Mercuric Nitrate.*" With the intention of preparing some fulminate of mercury, the author had dissolved some mercury in nitric acid, and from accidental circumstances had left the solution standing some days before adding alcohol. On the addition of this substance, and heating, a precipitate formed which was not fulminate of mercury. The investigation of this body is given in the present paper. Its formation was first observed by Soluro and Selmi, and afterwards investigated by Gerhardt, who describes it as a nitrate of ethyl, the hydrogen of which is entirely replaced by mercury, crystallised with a molecule of mercuric nitrate and 2 molecules of water, $C_4Hg_5(NO_3)_2Hg(NO_3)_22H_2O$: this substance was not re-crystallised, and was probably impure. Mercury is dissolved in twelve times its weight of nitric acid(1·3): the solution is allowed to stand until all nitrous

fumes have escaped, and the liquid is colourless; 12 parts by weight of pure alcohol, sp. gr. 0·80, are added, and the mixture heated. As soon as a precipitate forms the source of heat is withdrawn. The crystalline precipitate is washed with alcohol, and then with water. It was re-crystallised from dilute nitric acid (1 vol. in 4), and gave on analysis the formula $(C_2H_2Hg_3O_2)''(NO_3)_2$. It detonates when mixed with sand, and struck. If its temperature be raised rapidly, it explodes at 129° to 130°. If the temperature be raised very slowly it decomposes quietly, leaving oxide and nitrate of mercury. This substance can be prepared without heat. Treated with fuming nitric acid and alcohol it yields fulminate. It may be regarded as the nitrate of a dyad-radical, consisting of acetylene combined with mercury and mercuric oxide. By treatment with potash a hydrate was obtained $(C_2H_2Hg_3O_2)(HO)_2$. By treatment with potassic oxalate, an oxalate was obtained from the nitrate with the formula $(C_2H_2Hg_3O_2)C_2O_4$. Sulphuretted hydrogen decomposes the nitrate, forming mercaptan and mercury sulphide. In a note appended to the paper Dr. Debus looks upon this new base as belonging to the type glycol, $C_2H_4(HO)_2$, new base $(C_2H_2Hg_3O_2)(HO)_2$.

Dr. Debus referred to the interesting nature of the paper just read. This substance was interesting in two ways: first, because it was a step towards fulminate of mercury from alcohol and mercury nitrate, and, secondly, because of its constitution. He was at first inclined to view the substance as a compound of acetylene, C_2H_2, with ortho-nitrate of mercury, $C_2H_2.Hg_3(NO_4)_2$, but it was evident from its behaviour that we had really to do with an organic base containing mercury. In answer to a question of Dr. Armstrong he stated that free nitric acid was in all probability always present, as well as mercury nitrate.

"*On Boron Hydride*," by F. Jones and R. L. Taylor. The authors found that magnesium boride could not be formed by acting on borofluoride of magnesium with potassium. They give three methods for the preparation of this substance. The first consists in acting on boric anhydride with magnesium. Boric anhydride, which has been recently and thoroughly ignited, is mixed with twice its weight of magnesium dust, placed in a crucible the lid of which is firmly wired down, and heated in an ordinary fire. The reaction is violent; as soon as it is completed the crucible is removed from the fire, and allowed to cool. The residue in the crucible is chiefly a grey friable mass containing boride, nitride, and oxide of magnesium, also boron and magnesium. The second method consists in heating amorphous boron to a dull red-heat with magnesium dust in a current of hydrogen. In the third method the vapour of boron trichloride is passed over heated magnesium dust in an atmosphere of hydrogen. The first method is the most convenient for obtaining the magnesium boride in quantity. The boron hydride is obtained by heating magnesium boride with hydrochloric acid, but has not been obtained in a pure state, being always mixed with a large excess of hydrogen. The gas is colourless, with a most disagreeable odour, exciting nausea and headache, and is but little soluble in water. It burns with a green flame, which gives a brown stain on porcelain. It is decomposed by heat with separation of boron, and gives a black precipitate with silver nitrate, containing silver and boron. It combines with ammonia, yielding a compound which is decomposed by acids. The composition of the hydride, as far as could be ascertained by combustion of the mixture of hydride and hydrogen with copper oxide, is represented by the formula BH_3.

"*On the Action of Aldehyds on Phenanthraquinon in presence of Ammonia*," by Dr. F. R. Japp and Mr. E. Wilcock. In a previous paper the authors described the preparation of a benzenyl-amido-phenanthrol by the action of benzaldehyd containing hydrocyanic acid on phenanthraquinon. This same compound can be obtained with greater facility by heating phenanthraquinon, benzaldehyd and aqueous ammonia at 100° in an open flask on a water-bath. The substance when purified crystallises in tufts of colourless silky needles, fusing at 202°. Similar compounds have been prepared and studied by substituting cuminaldehyd or furfur-aldehyd for benzaldehyd. Acetaldehyd has no action on phenanthraquinon in presence of ammonia. If, however, phenanthraquinon was heated with aldehyd ammonia a product was obtained which could not be purified, and so its investigation was abandoned. By the action of salicyl-aldehyd on phenanthraquinon a new compound, $C_{21}H_{14}N_2O$, was obtained, a further investigation of which is promised.

"*On the Action of Benzoic Acid on Naphthaquinon*," by Dr. Japp and Mr. N. H. J. Miller. When naphthaquinon is heated with benzoic acid to about 160°, the liquefied mass almost solidifies from the separation of minute crystalline needles. Water is eliminated during the reaction. The product is purified by boiling first with alcohol to remove the excess of benzoic acid, then with aniline, and finally with alcohol again. The new compound is thus obtained in microscopic ramiform needles, fusing above the range of the mercurial thermometer, and insoluble in all solvents yet tried. Analysis gave results indicating the formula C_9H_4O. Its formation may be expressed thus:—

$$\underbrace{2C_{10}H_6O_2}_{\text{Naphthaquinon.}} + \underbrace{C_7H_6O_2}_{\text{Benzoic Acid.}} = C_{27}H_{12}O_3 + 3H_2O.$$

This compound is exceedingly stable. By oxidation with potassium permanganate in aqueous solution, phthalic, but no benzoic, acid is obtained. The authors find that naphthaquinon also reacts with various other acids, both monobasic and dibasic, yielding crystallised compounds which are still under examination.

In answer to Dr. Armstrong, who criticised the nomenclature employed in the first part, and thought it was misleading,

Dr. Japp stated that he had only followed the precedent of Ladenburg, who first prepared bodies of this class.

"*Note on the Appearance of Nitrous Acid during the Evaporation of Water*," by R. Warington. Schönbein stated some time ago that whenever pure water, or an alkaline solution, is evaporated, ammonium nitrite is produced, and that the same salt is formed during ordinary combustion in the air. It has been, however, since shown by Wright, Carius, &c., that this occurrence of nitrites is due to impurities, in the materials used or in the atmosphere, in which the experiments were conducted. The fact, however, still remains that pure water evaporated to a small bulk under the ordinary conditions will generally contain nitrous acid. The author has endeavoured to determine the conditions under which this occurs. He finds that pure water, when evaporated over a gas or even a spirit flame, always contains nitrites (1 litre of water in four hours contained 0·05 m.grm. of N); but that by using steam this quantity is diminished to one-twelfth, and by evaporating the water in a retort the introduction of nitrites could be altogether avoided. He proves also that distilled water, when exposed to the ordinary atmosphere of a room in an evaporating-dish, absorbs in a few hours sufficient nitrous acid to be detected. Less nitrous acid is obtained when the water is exposed in the country. Thus after twenty-seven days' exposure in fields, water contained nitrous acid equal to 1 part of nitrogen in 15 millions of water. In conclusion the author gave some account of the marvellously delicate test proposed by Griess, which far surpasses the delicate meta-phenylendiamine test. The latter can detect only 1 part of nitrogen as nitrous acid in 10 millions of water: the former gives a distinct reaction with 1 part in 1000 millions. The test is described in *Dent. Chem. Ges. Ber.*, 1879, 427. The solution to be tested is acidified with hydrochloric acid, a few drops of sulphanilic acid and a few drops of an aqueous solution of hydrochlorate of naphthylamin added: if nitrous acid is present a rose colour is developed; in strong solutions a dark red precipitate falls. The author expresses his obligation to Dr. Witt for calling his attention to the test and furnishing him with the necessary

materials. The author exhibited the delicacy of this test, and the absorption of nitrous acid from the atmosphere of the meeting-room, by a dish of water which had been exposed since six in the evening. The water immediately turned rose-red on the addition of the solutions.

Dr. Gilbert said that Mr. Warington had proved that the evaporation of water did not cause the oxidation of nitrogen, but that the nitrous acid which was found in water which had been evaporated was derived from combined nitrogen existing in the fuel or in the air. It was not, however, so clearly proved that the nitrous acid in the atmosphere was not produced by the oxidation of nitrogen.

Mr. J. Spiller had used the meta-phenylen-diamin test, and had reached the same limit of delicacy as that mentioned by Mr. Warington, 1 in 10 millions.

Dr. Wright then read a paper by Mr. Rennie and himself, "*On the Sweet Principle of* Smilax glycophylla." The leaves of this plant have long been used in Australia as a remedy for scurvy, &c., but no investigation of the sweet principle seems to have been hitherto made. The aqueous extract of the leaves was first treated with alcohol, to precipitate albuminous bodies, filtered, and the alcohol distilled off after filtration; the residue was then shaken up with ether two or three times. The ethereal extract on evaporation yielded a yellowish crystalline mass, readily soluble in boiling water. This substance on purification yielded a body, $C_{13}H_{14}O_6+2$ or $3H_2O$. Its molecular weight could not be determined. On fusion with potash at 250°, acidifying, &c., an acid, $C_9H_{10}O_3$, melting-point 127° to 128°, was obtained giving no colour reaction with ferric chloride, and an odour of a phenol when heated with soda lime. As the original substance extracted from the Smilax seems to have properties distinct from the active principle of ordinary sarsaparilla and from glycyrrhizin, the author suggests provisionally the name glycyphyllin.

"*Note on Usnic Acid and some Products of its Decomposition*," by the late J. Stenhouse and C. E. Groves. Pure usnic acid can be prepared from the crude acid, extracted from *Usnea barbata* by treatment with lime and water by first converting it into an insoluble basic compound (*Chem. Soc. Journ.*, 1880). This compound is then washed, decomposed by boiling with dilute hydrochloric acid, and the precipitate collected and washed. The precipitate is stirred up with a considerable excess of soda and hydrogen sodium carbonate added in excess; nearly pure sodium usnate is thus precipitated. This is purified by re-solution and re-precipitation. The pure sodium usnate is then dissolved in hot spirit containing soda, and acetic or hydrochloric acid added: pure usnic acid is thus thrown down in a crystalline state. If pure sodium usnate be boiled with dilute hydrogen sodium carbonate for some hours, air being excluded, a yellow solution is obtained, turning black on exposure to the air. When 1 part of usnic acid is dissolved in 3 parts by weight of strong H_2SO_4, the solution heated for three hours to 60°, and then cooled and poured into 15 parts of a water, a flocculent precipitate of usnolic acid, $C_{27}H_{24}O_{10}$, is formed. This substance after purification crystallises from hot spirit in small yellowish prisms, insoluble in benzene, carbon disulphide, and ether; readily soluble in dilute alkalies. From the formation of this substance, the authors suggest the formula $C_{54}H_{50}O_{21}$ for usnic acid, which also agrees well with the analytical numbers. The molecular weight of usnolic acid could not be fixed.

The next three papers were taken as read.

"*On the Absorption of Solar Rays by Atmospheric Ozone, and on the Blue Tint of the Atmosphere*," Part II., by W. N. Hartley. The author has adopted for the estimation of ozone the process in use at the Observatory of Montsouris. The ozone is absorbed in a solution of arsenious acid to which a little neutral potassium iodide has been added. The excess of arsenious acid is estimated with standard iodine solution. The following are the author's conclusions:—1. Ozone is a constituent of the higher atmosphere to a much larger extent than near the earth's surface. 2. Ozone is destroyed by contact with gases and organic matter in a moist atmosphere, as near the earth's surface, and that the collection of ozone from the air is attended by the destruction of it to a large extent. 3. The absorptive power of the ozone in the air is quite sufficient to account for the limitation of the solar spectrum. 4. The blue tint of the atmosphere is largely due to ozone.

"*On the Nature of Certain Volatile Products contained in Crude Coal-tar Benzenes*," by Watson Smith. The author has examined a sample of benzene from a London tar from the so-called "first runnings" of the still. After some weeks of continued fractional distillation the author split up the product with three main portions:—(1) boiling 40° to 53°; (2) 81° to 82°; (3) above 82°. No. 1 contained carbon disulphide equal to about 6 per cent of the original crude benzene, and by treatment with bromine furnished bibromamylene. No. 2 was pure benzene. The author looked carefully for alcohol and aceto-nitrile, but was unable to detect more than remote traces of either. It is stated by Vincent and Delachanal, and by Witt, that alcohol occurs in benzene distilled from coal-tar; but as the products with which they were worked were rectified, *i.e.*, treated with 3 per cent of strong H_2SO_4, followed by agitation with alkaline lyes and subsequent distillation, the author considers that the vinic alcohol might have been formed during this rectification.

"*Contributions from the Laboratory of the Royal College of Chemistry* (*On New Zealand Kawii Gum*)," by E. H. Rennie. This resin, the produce of the coniferous tree *Dammara Australis*, was first examined by Mr. R. D. Thomson, who obtained by distillation an amber-coloured oil to which he gave the name Dammarol. Mr. M. P. Muir also studied this substance, and by distillation obtained an oil boiling at 155° to 156°, to which he gave the formula $C_{10}H_{20}O_7$. The author has re-examined the subject. He heated the gum in a copper vessel through which a rapid current of steam was passing: 15 lbs. of the resin yielded 750 c.c. of oil. By re-distillation a large portion was obtained boiling at 157° to 158°, colourless, with a strong odour of turpentine. On analysis it gave numbers indicating $C_{10}H_{16}$. It had a very slight action on polarised light. By the action of phosphorus pentasulphide, &c., some cymene was obtained. On oxidation it yielded terephthalic and acetic acids. It therefore appears that the oil produced by the distillation of Kauri gum consists almost entirely of a terpene resembling the other members of the family.

The Society then adjourned. The Anniversary Meeting will take place on March 30th, when the Longstaff Medal will be presented to Dr. Thorpe. The next ordinary meeting is on April 7th, when a paper will be read "On the Estimation of Hydric Peroxide by Means of Potassic Permanganate," by W. E. Adeney.

CORRESPONDENCE.

SMOKE AND FOG.

To the Editor of the Chemical News.

Sir,—I have perused your review of the work of Mr. F. Edwards (which I have not yet read), on London smoke, fog, &c., in which he refers to a proposition of mine, made by me nearly twenty-five years ago, for getting rid of the smoke of large towns. Mr. Edwards dismisses my scheme because of its engineering difficulties, and no doubt there are such, though not I think fatal ones; but the only one of these he specifies shows that he did not consider my scheme of so much importance as to induce him to make any calculation as the basis of his condemnation.

I proposed a chimney for Manchester 600 feet high and 100 feet internal diameter; this would give a circular area

of 7500 feet (and I should build my chimney circular), but Mr. Edwards says that for London it would require a diameter of 720 feet; this would give a circular area of 385,800 feet, over fifty times what is required for Manchester. Now Manchester by next census will be found to have a population of considerably over 600,000, or at least one-seventh of that of London. As I allowed an exit for ten times the quantity of air during the working day, required to consume all the coal used in Manchester, I think the same ratio ought to be ample for London. A chimney 300 feet diameter gives a circular area of 67,000, or nearly ten times what Manchester requires. Probably, if Mr. Edwards would go into the other engineering difficulties they might also become in appearance less formidable, and at least surmountable. That sufficient ascensive power can be got by this means to carry all the London smoke so high as to convey it by diffusion and otherwise out of the habitable region is unquestionable, while the increasing annoyance growing in power year and year will at last, I have little doubt, culminate in such a catastrophe as I pointed out as a possibility. That, given an atmosphere, still, and with little tendency to diffusion under the influence of a dense fog, with all the produced carbonic acid accumulating, it might reach the point of 7 per cent of that gas, which would render it as instantly destructive of life as the Grotto del Cane, or the workings of a coal-pit after an explosion of carburetted hydrogen gas.

This is a serious matter for Londoners, and though not yet a probable event is certainly possible, and will become more highly probable as time goes on.

But, Mr. Editor, why not combine my scheme with one still greater, and which when united would enable the living to live longer and much more comfortably, and when dead—as die they must—provide for them a quiet and secure resting-place near to the scene of their life's labours? Let 100 acres of land be laid out in a circular area of about 2040 feet diameter, in a convenient locality. In the centre of this build my chimney, 300 feet diameter, with walls 20 feet thick at the base, and with arches at regular intervals to receive the underground ventilating drains. These arches must radiate out all round for 850 feet. When filled up level the top of these arches would form a circular plain on which to build catacombs, somewhat similar to those of ancient Palmyra, the plain having a slight incline, so that one generation working round would cover up its predecessor, and form a basis for the succeeding generation. Thus, like a new Tower of Babel, would the vast mound grow up, till it reached the top of my chimney, which might be 1000 feet high. An inclined roadway would wind up on the outside of the catacomb area, gradually, of course, narrowing the space; but by beginning with an area of 3000 feet instead of 2000 feet, it would still be a large space, probably a century hence, with "ample room and verge enough" for many other generations to be gathered to their fathers: this, however, would require another 100 acres of land to commence with. All this catacomb space would have ventilating shafts communicating directly with the great chimney, preventing the slightest smell or taint from the whole structure. The monumental records could all be placed on the surface, but would be covered up by the succeeding range of structure; but some means might be found of ensuring a little longer immortality.

My scheme, Mr. Editor, has claims upon the dead as well as upon the living; but if the latter would only lay it to heart I have no fear of the former objecting to so comfortable and stable a domicile in which to sleep through the ages, awaiting the trumpet's call.

If something is not done by the living, then the fog, like the sword of Damocles, will continue to hang over the denisens of London. Anthracite coal, or half carbonised bituminous coal, is only a fallacious cure, as the resulting gases are not thereby diminished or made in the least degree less deleterious. Get them raised a a thousand feet into the atmosphere, and the law of diffusion will do the rest for you; but you must have my chimney or else some better scheme.—I am, &c.,

PETER SPENCE.

Erlington House, Manchester,
March 21, 1881.

DEOXIDATION OF NITRATES.

To the Editor of the Chemical News.

SIR,—As chemists are at present much interested in nitrates, I may mention the following from a paper written some months ago: I cannot be sure of the time when it may be published:—

"A peculiar putrefactive condition produces a deoxidation of nitrates. In some conditions nitrogen is eliminated as gas, the oxygen going to the carbon in whole or in part. In weak solutions containing water enough to absorb the carbonic acid (probably), nearly pure nitrogen may be obtained with considerable rapidity."

I mentioned this as probable in my paper on "Organic Matter in Water," 1868; the words may be quoted:—"After putrefaction has occurred in the Medlock, at Manchester, I have not found it" (nitric acid). "The oxygen seems to be removed as the oxygen of the air is, probably leaving nitrogen to pass off as gas."—I am, &c.,

R. ANGUS SMITH.

March 21, 1881.

A SCOLDING!

To the Editor of the Chemical News.

SIR,—The notice of my paper (CHEMICAL NEWS, vol. xliii. p. 42), under "Proceedings of Societies," is a puzzle. The paper, it is stated, was taken as read. If so, if something has been read substantiating the notice, it is not my paper that has been read; and if my paper has been read the notice is a misrepresentation. The substance of the paper is the setting forth of a fact; the relative weight of undoubtedly single molecules, for the first time in the history of chemistry, determined in an unobjectionable manner and independently of all theory or hypothesis, is communicated. Numerous facts illustrating and confirming the weights found are then quoted. The notice says the paper "consists of a lengthy theoretical disquisition, in which the author maintains the following propositions:—That the combining weights of all elements are one-third of their present values," &c. The difference between the disclosing and substantiation of a fact and a theoretical disquisition is so great that the idea of a misunderstanding is excluded, and the notice presents itself as a deliberate, studied misrepresentation, with regard to which I beg leave to state that I cannot indorse a resort to fraud in scientific circles of high repute, seemingly for no other purpose than to elude the consideration of unwelcome scientific facts.—I am, &c.,

E. VOGEL.

San Francisco, February 28, 1881.

[Our report of the meeting of the Chemical Society on January 20th was official. An author who says that "the cause of chemical action is undoubtedly atmospheric pressure" can scarcely complain if his paper is called "theoretical."—*Ed.* C.N.]

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—It may interest your readers, and tempt them to exert their ingenuity, to copy a question lately given at an Oxford examination for a Studentship in Natural Science. The question is "In what relation do single substances stand to other objects, and elements to other single substances?" This question does honour to the examiner, both by its ingenuity as well as by the clear and lucid language in which it is couched.—I am, &c.,

F. I. C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 9, February 28, 1881.

Action of Hydracids upon Halogenous Salts containing the same Element.—M. Berthelot.—Compounds formed by the union of a hydracid and a haloid salt containing the same element, exist as well in the case of alkaline salts, where they are marked out by the absorption of the gas, by the liberation of chlorine and by special reactions, as in case of the metallic salts, properly so-called where they are obtained in crystals. In both cases they are partially dissociated. Such compounds, far from being exceptional, represent a very widely distributed order of bodies. Among the monobasic acids, acid acetates and formiates have long been known. M. Ditte has recently called attention to the acid nitrates, and in a narrower range of analogies, we may recall the hydrofluorates of the alkaline fluorides. The hydrochlorates of the chlorides and the hydrobromates of the bromides are compounds of the same class distinguished merely by a less degree of stability.

Disinfecting and Antiseptic Action of the Vapour of Nitrous Ether.—M. Peyrusson.—This ether has proved successful as a disinfectant both in laboratory experiments and in medical practice.

Radiophony.—E. Mercadier.—The author has constructed instruments which may be called thermophonic batteries or phonic thermomultipliers.

Application of the Fringes of Talbot for the Determination of the Indices of Refraction of Liquids.—M. Hurion.—A mathematical paper, not capable of useful abstraction.

Displacement of the Soda of Sodium Chloride by Copper Hydrate.—D. Tommasi.—Copper hydrate in a moist state possesses the singular property of liberating a certain quantity of alkali, if it is brought in contact with certain saline solutions, such as sodium and potassium chloride, potassium bromide, sodium sulphate, &c. The displacement of the alkali takes place even at temperatures as low as 4° and 5°. If copper hydrate, well washed, and moist, is added to a solution of sodium chloride at 10 per cent, the liquid in a few minutes acquires an alkaline reaction, which increases on standing. Meantime the hydrate is converted into a pale green powder, containing chlorine. Moist copper carbonate acts in a similar manner.

Combustion-Heats of Certain Alcohols of the Allylic Series and of their Isomeric Aldehyds.—W. Louguinine.—The author has determined the combustion-heats of allyl-dimethyl-carbinol, allyl-dipropyl-carbinol, menthol, diallyl-methyl-carbinol, and valeric aldehyd. The difference between the combustion-heats of œanthol and valeric aldehyd is 320,439 cals.

Products of the Splitting-up of Proteic Substances.—A. Bleunard.—The author has prepared in a state of purity the compound $C_4H_7NO_3$, which is obtained along with gelatine-sugar, when bromine is allowed to act upon gluco-proteine in presence of water.

Synthetic Homologue of Pelletierine.—A. Etard.—The hydrogen contained in ammonium hydrochlorate acts as a reducing agent upon glycerin, eliminating its hydroxyls in the state of water. The result of the reaction is an oxygenous alkaloid, C_6H_9NO, isomeric with one of the hydroxy-picolines, which the theory of the pyridic series enables us to foresee.

A Cause of Deterioration in Cloth.—M. Balland.—Goods dyed rust, buff, or chamois shades with salts of iron occasionally undergo a slow combustion. The ferric oxide is alternately reduced by the organic matter of the tissue and re-oxidised by the oxygen of the air.

Reimann's Färber Zeitung, No. 40, 1880.

This number contains nothing of general interest.

No. 41, 1880.

At a Berlin feather-dyeing establishment an ostrich feather dyed in shades with methyl-violet was laid upon a paper upon which some ammonia had been poured but had dried up again. After a time the feather became partially green, the green passing gradually into violet, and producing an extraordinary effect. This reaction is being utilised in feather-dyeing, and will probably be applied in the manufacture of artificial flowers.

The colours prepared by Meister, Lucius, and Brüning, and by the Berlin "Actien Gesellschaft für Anilinfabrikation," and sold as Ponceau, are formed by associating disulpho-naphtholic acid with cumidine.

MISCELLANEOUS.

College of Agriculture.—At a meeting of the Council of the Wilts and Hants Agricultural College, at Downton, Salisbury, on Wednesday, it was unanimously resolved that the College should be henceforth called the College of Agriculture.

Truth is Stranger than Fiction.—Our contemporary *Truth*, discoursing on nitroglycerine, instructs its readers as follows:—"The explosive character arises from this: nitrogen is composed of molecules in pairs of atoms. Nitric acid contains only one atom in its molecules. Upon this atom being set free from its unstable combination in the glycerine, the two atoms of nitrogen rush together, producing a vast amount of energy of combination in the shape of heat. The gaseous products are thus heated, and an explosion takes place immediately."

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Annual production of Alum, &c.—Can anyone give the annual United Kingdon production each of alum, alum cake, and sulphate of alumina, and the average price for the last five years?—ALUM.

Patent Dryers.—Will some correspondent kindly inform me what should be the composition of the so-called "patent dryers" used by painters; whether barium sulphate and calcium carbonate are adulterants, and, if not, for what purpose they are added? I should also like to know if lime is ever a constituent of these dryers.—L. A.

MEETINGS FOR THE WEEK.

MONDAY, 28th.—Medical, 8.30.
—— Society of Arts, 8. "The Scientific Principles Involved in Electric Lighting," Professor W. G. Adams, F.R.S.
—— Royal Geographical, 8.30.
TUESDAY, 29th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
—— Civil Engineers, 8.
WEDNESDAY, 30th.—Society of Arts, 8. "Recent Advances in Electric Lighting," W. H. Preece, M.Inst.C.E.
—— Chemical. Anniversary, 8.
THURSDAY, 31st.—Royal, 4.30.
—— Royal Institution, 3. "Ornament," Mr. H. H. Statham.
FRIDAY, April 1st.—Royal Institution, 8. "The King, in his Relation to Early Civil Justice," Sir H. S. Maine, 9.
—— Geologists' Association, 8.
SATURDAY, 2nd.—Royal Institution, 3. "American Humourists," Rev. H. R. Haweis.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLIII. No. 1114.

ON THE

BASES PRODUCED BY THE DISTILLATION OF CINCHONINE WITH POTASH.

By C. GREVILLE WILLIAMS, F.R.S.

In the Chemical News, vol. xliii., p. 130, in noticing the chemical papers in the *Comptes Rendus* for February 21, the paper of M. Oechsner de Coninck on "Pyridic Bases," is called "A further account of the three bases which the author discovered in the products of the distillation of cinchonine with potassa." The three bases alluded to are lutidine, collidine, and parvoline. The author appears, as regards the first two bases, only to have seen a short notice of my first memoir, which appeared in the *Ann. Chim. Phys.*, xlv., p. 488. As regards parvoline, I discovered it in 1854 (*Quart. Journ. Chem. Soc.*, July, 1854). Chemists are aware that I regard the lutidine obtained from cinchonine as isomeric and not identical with the base of the same composition from bone-oil. In my "Researches on Isomeric Alkaloids" (*Proc. Roy. Soc.*, June, 1864), I have given the results of a laborious comparison between the lutidine of Anderson and the lutidine from cinchonine, and the results clearly showed their isomerism; I therefore provisionally gave the latter base the name of β-lutidine. M. Oechsner de Coninck's first paper (*Bull. Soc. Chim. Paris*, Sept., 1880) contains such a number of analyses, densities, vapour-densities, &c., which have *all* been done by me before, that it is evident he has not consulted my original papers. In an article on β-lutidine, which I hope soon to have the honour of bringing before the Royal Society, I shall enter into the question at greater length.

ON THE

ACTION OF SODIUM UPON CHINOLINE.*

By C. GREVILLE WILLIAMS, F.R.S.

In 1867 I made some experiments on the action of sodium upon chinoline and lepidine, and found that a substance was produced which dyed silk a beautiful but fugitive orange colour. I announced this fact in a paper "On the Higher Homologues of Chinoline."† I made analyses of the products at the time, but the difficulties in the way of preparing them pure were so great, and that me at my disposal was so limited, that I did not make public any quantitative results until March, 1878, when I published a short note "On the Action of Sodium on Chinoline and Lepidine."‡ In that paper I gave the results of an analysis of a product from chinoline, which agreed with the formula $C_{18}H_{14}N_2.HCl$, which is obviously that of the hydrochlorate of dichinoline. I also gave an analysis of the nitrate of dilepidine, which agrees almost perfectly with the theoretical values; but I did not enter into the details of the modes of preparation. In the course of my investigation of β-lutidine, it was natural that I should study the action of sodium upon it, but I met with so many and unexpected difficulties that I determined to prepare myself for a new attack upon the subject by a fresh investigation of the action of sodium upon chinoline. As I find that other observers are working upon chinoline, β-lutidine, and β-collidine,* I have thought it desirable to bring before the Society the results obtained, although the investigation is still proceeding.

Action of Sodium upon Chinoline.

The action of sodium on chinoline is exceedingly remarkable, not merely because it polymerises the base, for a similar result, as is well known, takes with picoline, but because the products have properties which are, I think, different from any yet observed among organic substances. For a yellow oil like dichinoline to yield a true although fugitive dye, in the form of a brilliantly red crystalline hydrochlorate, is probably a unique reaction. To obtain this product of the utmost beauty, it appears to be necessary that the chinoline should be perfectly free from any impurity, except, perhaps, its next homologue. The most successful preparations were made from chinoline obtained from fine crystals of the chromate †

Chinoline prepared from the chromate is almost colourless, and becomes yellow, on keeping, with extreme slowness as compared with the base prepared without that precaution. In the following experiments it is to be understood that all the chinoline was prepared from the crystallised chromate.

Chinoline was boiled with sodium, the fluid, which became purplish crimson, was treated with water, which at once converted the crimson colour into a dirty yellow. Hydrochloric acid was then added, and the solution became of an intense orange colour. The solution was boiled, filtered, and allowed to stand two days, the crystals of hydrochlorate of dichinoline were filtered off, and the mother-liquid was precipitated fractionally by solution of platinic chloride. The first precipitate was of a light orange colour, the second a deep orange, the third Naples yellow, the fourth was in the form of a brown crystalline powder. The platinum was determined in each with the following results:—

No. of Precipitate.	Percentage of Platinum.
I...	22·59
II...	23·83
III...	28·30
IV...	28·59

The first result agrees with the numbers required for the formula—

$$2(C_{18}H_{14}N_2)HCl.PtCl_4,$$

which requires 22·18 per cent of platinum. The second is probably a mixture of the substance having the formula of the first precipitate with some of that having the formula of the third, which latter agrees fairly with a salt having the formula—

$$C_{18}H_{14}N_2.3HCl.PtCl_4,$$

which requires 28·00 per cent of platinum. The formula—

$$C_{18}H_{14}N_2.2HCl.PtCl_4,$$

requires 29·51 per cent. There are other formulæ which agree with the numbers obtained, but they do not appear to me so readily admissible. For instance, a substance having the formula—

$$2(C_{18}H_{14}N_2)PtCl_4,$$

would require 23·13 per cent of platinum, which would agree with the amount of metal obtained from the second precipitate, but the formation of such a substance in the presence of free hydrochloric acid appears most unlikely. Nevertheless, it is remarkable that the platinum salt obtained from the products of the action of sodium on chinoline and β-lutidine, often agree in their percentages of

* A Paper read before the Royal Society, March 17, 1881.
† *Laboratory*, May, 1867, p. 109.
‡ Chemical News, vol. xxxvii., p. 85.

* *Bull. Soc. Chim.*, [2], xxxii., 486 to 487); Boutlerow and Wischnegradsky, *loc. cit.*, No. 9, June 5, 1880; Oechsner de Coninck, *Bull. Soc. Chim.*, Nos. 4 and 5, p. 210, September 5, 1880. The latter chemist has repeated several of my older experiments, evidently under the impression that they had not been made before.

† It is much to be desired that those chemists who believe in the identity of chinoline and leucoline, and who possess the latter in a pure state, would study the action of sodium upon it; as, if it yields the crystalline scarlet hydrochlorate, the question might be considered as settled.

platinum with substances having formulæ of the polymerised bases united directly to platinic chloride.

Action of Sodium Amalgam on Chinoline.

25 grms. of chinoline and 20 grms. of sodium amalgam containing 10 per cent of sodium were mixed. The action commenced in the cold, and red streaks appeared where the base and the amalgam were in contact. When the action ceased in the cold, the mixture was warmed on the water-bath; the reaction started again immediately, and the whole became of a deep red colour. No gas was given off. The next day the mixture had assumed the consistence of thick treacle; when heated on the water-bath it softened, but the amalgam remained hard; the fluid had turned from purplish red to yellow, but reddish streaks were still formed on stirring, showing that the reaction was not complete. At this stage 5 grms. more amalgam were added. After four or five hours of constant stirring on the water-bath the red streaks ceased to appear, and the whole became a greenish yellow oil, the greater portion of which was poured off, and the residue containing much undecomposed amalgam was treated with hot water. The amalgam decomposed with violence, and when the action was over excess of hydrochloric acid was added, and the solution was boiled and filtered. Three liquors were taken off and kept separate from each other; each solution gave on cooling crystals of the hydrochlorate of dichinoline; they were in the form of needles of so brilliant a scarlet that, on comparison with a sample of the finest vermillion, the latter looked brown by contrast with them. The first solution yielded 1·1 grms. of air-dried product, the second 0·4, and the third 0·25, in all 1·75 grms. from 25 grms. of chinoline. The scarlet crystals bleach on exposure to light and become pale brown on drying in the water-oven, and the brown colour itself rapidly bleaches on exposure to light.

The mother-liquors of the scarlet crystals on evaporation to a quarter of their original bulk, deposited a pale yellow precipitate too small for analysis; it was nearly insoluble in cold water.

The mother-liquors affording no further crystals on evaporation were treated with excess of potash to enable the chinoline to be recovered; 11 grms. were obtained, being 44 per cent on the chinoline taken; deducting the recovered chinoline from that originally employed, the produce of the scarlet crystals become 12·5 per cent on the base originally taken.

Action of Sodium Amalgam on the Recovered Chinoline

The recovered chinoline was dried by sticks of potash for a short time, and then rectified to see if its boiling-point had undergone any alteration by the treatment with sodium amalgam; however, it came over at almost exactly the same point as it did before. It is very remarkable that in spite of the fact last mentioned, the product of the action of the amalgam upon the recovered base was of a totally different character to that of the same reagent upon the original chinoline.

The 11 grms. of recovered chinoline were treated with 20 grms. of amalgam, effervescence took place, and much heat was developed; this was possibly caused by traces of moisture remaining in the base. When the effervescence was over, 5 grms. more amalgam were added, being in all 30 grms. for 11 of base, whereas in the first experiment equal parts of base and amalgam were used; this fact has to be remembered in considering the causes of the different result. The red colouration took place as before; it is, however, a very ephemeral reaction, the colour on a glass rod soon disappears, and does so immediately on spreading the substance in a thin layer on the side of the beaker in which the operation is conducted. The experiment was made precisely as with the original chinoline, and the reaction appeared to proceed exactly in the same manner as before; but, on boiling out with dilute hydrochloric acid, the product of hydrochlorate of dichinoline was much smaller, and the crystals were too small to be distinguished as such by the naked eye.

The mother-liquors were treated with potash, as before, to enable the chinoline to be recovered, when to my surprise a *solid yellow base* was obtained, which on boiling some time with water to expel any adhering chinoline, became, on cooling, a hard resinous mass; on drying in the air it weighed 7 grms., or 63 per cent on the 11 grms. of recovered chinoline used.

In order to gain some insight into the nature of the new solid base, it was converted into a hydrochlorate and fractionally precipitated with platinic chloride. 1 grm. was dissolved in 50 c.c. of hot diluted hydrochloric acid; on cooling a part separated out; this could have been prevented by a great excess of hydrochloric acic, but on this occasion the separation was permitted as a mode of purification. The precipitate was filtered off, and some hydrochloric acid was added to prevent the water in the solution of platinic chloride from causing a further precipitation. On adding the platinum solution, a dense bright yellow precipitate was formed; to the filtrate more platinum solution was added, and so on until four precipitates were obtained. The second, third, and fourth were buff coloured, but the last on standing became of a dirty buff colour. The last two were in too small quantity for analysis.

The first precipitate gave 18·47 per cent of platinum. Assuming for the present that the yellow solid base from the recovered chinoline is isomeric with that which yields the scarlet hydrochlorate, it may be mentioned that a salt having the formula $2(C_{18}H_{14}N_2)4HCl.PtCl_4$, would require 19·76 per cent of platinum. The second precipitate gave 23·49 per cent of platinum, and yielded, therefore, almost the same percentage of the metal as the second precipitate obtained from the product of the action of sodium upon the original chinoline, and the remarks made upon that precipitate apply equally to the present one.

Experiments were subsequently made to ascertain if, in presence of excess of hydrochloric acid, platinum salts of a different constitution would be formed. For this purpose 1 grm. of the new solid base was treated with 10 c.c. of *strong* hydrochloric acid, it dissolved with effervescence as if carbonic anhydride had been absorbed; the solution took place with moderate readiness; it was filtered and treated with solution of platinum as before, a buff-coloured precipitate was obtained. At this point 10 c.c. more hydrochloric acid were added, the precipitate became smaller; 25 c.c. more hydrochloric acid were added at this stage, and the solution was heated to about 90° and filtered. Much of the platinum salt remained on the filter, and after drying gave 23·92 per cent of platinum; the mother-liquid on cooling gave another precipitate containing 24·55 per cent of platinum. Both these precipitates appear, therefore, in spite of the great excess of acid in which they were formed, to be constituted like the second precipitates previously obtained.

The solid yellow base contained 3·06 per cent of ash, which consists of carbonate of lime with a trace of iron, both derived from the chemicals used in its preparation.

The solid base when heated fuses to a yellow oil, giving off precisely the same odour as chinoline compounds generally; near a red heat it boils away, leaving some carbon, which, contrary to the usual rule in such cases, burns away readily.

Nitric acid dissolves the base easily, giving a reddish brown solution, which, on dilution with water, affords a yellow precipitate; ammonia turns the solution red, and partially dissolves the precipitate.

Preparation of the Platinum Salt from the Scarlet Hydrochlorate of Dichinoline.

The scarlet hydrochlorate of dichinoline was dissolved in boiling water, and precipitated while boiling by an excess of platinic chloride. The high temperature of the solution was necessary to prevent the precipitation of the hydrochlorate with the platinum salt. The latter was o

a beautiful pale cadmium yellow colour. The filtrate on cooling yielded fine needles in extremely small quantity. The precipitate contained 24·54 per cent of platinum, and probably, therefore, had the same composition as those before mentioned, containing the same or nearly the same amount of platinum. The needles contained 35·7 per cent of platinum, and it is most likely that the presence of a small quantity of this salt was the cause of the high platinum in the first precipitate. A direct combination of dichinoline with platinic chloride, $C_{18}H_{14}N_2.PtCl_4$, would require 33·11 per cent of platinum, but it is not easy, as I have said before, to admit such a formula, when it is remembered that the precipitation took place in the presence of hydrochloric acid.

A salt of the formula $2(C_{18}H_{14}N_2)HCl.2PtCl_4$, would require 33·66 per cent of platinum, and would only differ from the salt $2(C_{18}H_{14}N_2)HCl.PtCl_4$, before alluded to, and which contains 22·18 per cent of platinum, by containing one more equivalent of platinic chloride. It must, however, be distinctly stated that the numbers in this paper are given provisionally, and that the subject is still under study.

THE ESTIMATION OF PHOSPHORUS IN STEEL

By J. OLIVER ARNOLD, F.C.S.

THE accurate determination of phosphorus in steel is perhaps the most important problem with which the steel chemist has to deal, and there is a great diversity of opinion as to which is the best method to use for its estimation.

In the majority of the iron and steel laboratories the method known as the "molybdate" is used; in some few that known as the "magnesia" method. Some chemists, and prominently Mr. Riley, state that results obtained by the molybdate process are generally lower than results obtained by the magnesia method; others maintain that the two methods agree. When commencing the experiments enumerated below, I had a mental impression that the two processes would practically agree.

For the purposes of the experiments, a large quantity (about 500 grms.) of ordinary Bessemer steel was selected, drilled, and carefully bottled. Six quantities, varying from 4 to 6 grms., were taken, and the phosphorus was carefully estimated by the molybdate process, which is briefly as follows:—

The steel is dissolved in warm 1·20 HNO_3, evaporated to dryness, and strongly heated; the dried oxide is taken up with HCl, silica, &c., is filtered off, and the solution is evaporated to the lowest possible bulk, a few c.c. of HNO_3 added, and then a moderate excess of a nitric acid solution of ammonic molybdate. The yellow phospho-molybdate is allowed an hour or two at a temperature of about 70° C. to precipitate; it is filtered off, washed with HNO_3 water, dried at 100° C., and is brushed from the filter paper, and weighed. The results were:—

	Per cent Phosphorus.
A	0·0605
B	0·0680
C	0·0638
D	0·0713
E	0·0593
F	0·0627
Mean	0·0643

Six more determinations on similar quantities were now made by the magnesia method. The steel was dissolved, and dried down as before, taken up in HCl, transferred to a flask, and diluted to 750 c.c. with a dilute solution of Na_2SO_3. After reduction the solution was boiled, nearly neutralised with AmHo, ammonium acetate and a few drops of Fe_2Cl_6 added, and the solution again boiled. The resulting precipitate was dissolved in HCl, and evaporated to a bulk of about 10 c.c. After the addition of 10 c.c. of a strong solution of citric acid, the solution was made strongly alkaline with ammonia, and finally mixed with 2 c.c. of magnesia mixture. After standing thirty-six hours with occasional stirring, the precipitate of $AmMgPO_4$ was filtered off, washed with AmHo water, and was dried, ignited, and weighed as $Mg_2P_2O_7$. Results:—

	Per cent Phosphorus.
A	0·0755
B	0·0762
C	0·0737
D	0·0766
E	0·0778
F	0·0800
Mean	0·0766

The magnesia thus gave a mean of 0·0123 per cen higher than the molybdate; the slight loss resulting in brushing out the molybdate precipitate will not account for this large discrepancy. In every case, on boiling the filtrate from the phospho-molybdate, a further precipitate was obtained, mixed, however, with MoO_3. It should be noted that in the case of the molybdate, the hygroscopic nature of the precipitate would tend to make the result higher than the truth. Three estimations were now made on 5 grms. of the steel after adding the following quantities of $Mg_2P_2O_7$. The pure salt was taken and ignited, and the weighings made when cool.

	Grms.		P.c. Phosphorus.		P.c. Phosphorus.
A	0·0077	=	0·0431	gave	0·1158
B	0·0122	=	0·0682	,,	0·1348
C	0·0139	=	0·0777	,,	0·1488

Subtracting from the total result the average of the steel results, by magnesia, the results are:—

	Theory p.c.		Found p.c.		P.c. low.
A	0·0431	–	0·0392	=	0·0039
B	0·0682	–	0·0582	=	0·0100
C	0·0777	–	0·0722	=	0·0055

Mean low .. 0·0065 per cent.

This indicated the magnesia method to be slightly low. A similar trial was now made with the molybdate method. Added pure $Mg_2P_2O_7$.

	Grm.		P.c. Phosphorus.		P.c. Phosphorus.
A	0·0150	=	0·0839	gave	0·1129
B	0·0090	=	0·0503	,,	0·0928

Subtracting the average by molybdate we get:—

	Theory p.c.		Found p.c.		P.c. low.
A	0·0839	–	0·0486	=	0·0353
B	0·0503	–	0·0285	=	0·0218

Mean low .. 0·0285 per cent.

This result shows the molybdate method to be seriously low. This is to be attributed to the fact that the presence of so large an amount of Fe_2Cl_6, and of the free HCl which it is impossible to get rid of by evaporation, retains a portion of the phosphoric acid in solution.

The next experiment was made on 5 grms. of the steel, to see if by boiling the solution and bringing down free MoO_3 the whole of the H_3PO_4 could be precipitated. The precipitates were washed with HNO_3 water, dissolved in AmHo, and re-precipitated with magnesia. Results:—

	P.c. Phosphorus.
A	0·0654
B	0·0690

The result still being low an attempt was made as follows:—

The viscid solution was neutralised with AmHo and the iron precipitated taken up in 1·40 HNO_3, molybdate added, and the solution boiled, the precipitate being treated as in the preceding experiment. Results:—

	P.c. Phosphorus.
A	0·0721
B	0·0692

These last results, though slightly higher, show that it is impossible to precipitate the whole of the phosphoric acid in the presence of the total amount of iron. Mr. Riley, in a paper on the estimation of phosphorus in steel, read before the Chemical Society in March, 1878, proposed the following modification of the molybdate method:—"The method I propose is to dissolve the steel or iron in 1·20 nitric acid, avoiding as much excess as possible; to the solution, diluted to rather more than half a pint, sodium sulphite is added, so as to reduce the iron to FeO after boiling off the sulphite (a large excess should be avoided); the phosphorus is precipitated with some peroxide as basic acetate and phosphate, precisely as in the magnesia method; the precipitate is dissolved in hydrochloric acid, the solution made alkaline with ammonia, and the precipitate formed is dissolved in 1·40 nitric acid. The solution is then precipitated with molybdate of ammonia in the ordinary way." He also gives the result of an unsuccessful experiment by the process.

Two experiments made by this method on 5 grms. of the standard steel, gave—

	P.c. Phosphorus.
A	0·0722
B	0·0720

This shows an improvement, but the result is still lower than the magnesia result.

Proceeding on the principle of the above method, but evaporating the HCl solution of the phosphate and basic acetate of iron to a very low bulk (about 5 c.c.), the solution was neutralised with AmHo, and the precipitate obtained taken up in 1·40 HNO_3. By this treatment all free HCl is got rid of, and a nitric acid solution of the phosphate obtained, which is precipitated with the molybdate reagent and boiled, a considerable amount of free MoO_3 coming down in addition to the phosphorus salt. This precipitate was thoroughly washed with HNO_3 water till free from any trace of Fe, re-dissolved in AmHo, and a portion of the latter neutralised with HCl to form AmCl, and finally 2 c.c. of magnesia mixture added; the total bulk of the solution should be about 40 c.c. Five estimations on 5 grms. each gave—

	P.c. Phosphorus.
*A	0·0775
*B	0·0810
*C	0·0789
D	0·0857
E	0·0855
Mean	0·0817

* These estimations were precipitated in a bulk of 100 c.c.

This result is higher than the magnesia mean by 0·0051 per cent.

To see how the results by this method agree with theory, 0·0113 grm. $Mg_2P_2O_7$ was added to 5 grms. of the steel; this weight of magnesia salt being equivalent to 0·0632 per cent P. Result—

0·1460 per cent phosphorus.

This – 0·0817 per cent, the average in the steel by this method, gives—

Theory p.c.	Found p.c.
0·0632	0·0643

This would indicate the method to be very accurate, more so than the ordinary magnesia. In an analysis of axle steel my colleague, Mr. King, kindly made an estimation by both methods, which gave—

	P.c. Phosphorus.
A—Magnesia method	0·0681*
B—Modified method	0·0794

* Allowed 30 hours to precipitate.

Thus bearing out my results. The length of the magnesia method is also a very serious drawback; the molybdate, though rapid, is not reliable, as the results are nearly always low. The proposed modification of the two methods takes a rather longer time than the molybdate to carry out, but is much shorter than the magnesia, as the double phosphorus salt is completely precipitated in four to six hours, whereas the magnesia requires thirty-six hours, and it would seem that even after that time the presence of the double citrate of iron and ammonium retains a small amount of phosphate in solution.

Summary.

1. That the phosphorus contained in a steel cannot be totally precipitated in the presence of the total amount of iron by ammonic molybdate.

2. That even if the greater portion of the iron is removed as in the magnesia process, and is treated as described above, the whole of the H_3PO_4 cannot be precipitated at a temperature low enough to obtain the definite salt of molybdic acid.

3. That if the solution be boiled the whole of the phosphoric acid comes down with varying quantities of free MoO_3, and that on dissolving this precipitate (after thoroughly washing with nitric acid water) in AmHo, and forming AmCl by neutralising a portion of the ammonia with HCl; the whole of the H_3PO_4 may be obtained on addition of a magnesia salt as $AmMgPO_4$.

4. That the magnesia method is slightly low, probably owing to the slight solubility of $AmMgPO_4$ in the double citrate.

An experiment was made to see what the influence of unwashed filters would be on a phosphorus determination, as in the course of the analysis at least two filters are treated with HCl. Ten best Swedish filters 120 m.m. in diameter gave—

$Mg_2P_2O_7$ .. .. 0·0043 grm.

In an estimation on 5 grms. of steel this would give an error of 0·0048 per cent high; it is therefore advisable to wash all filters used in phosphorus-determinations.

I have no hesitation in adding that many of the hurried estimations of phosphorus, carried out by the molybdate process in the laboratories of iron and steel works, are utterly unreliable.

Sheffield, March 17, 1881.

ON THE

ELIMINATION OF CARBON DISULPHIDE FROM COMMERCIAL BENZOL.

By BENJAMIN NICKELS.

THE paper of H. Macagno, appearing in the CHEMICAL NEWS, vol. xliii., p. 138, on the "Analysis of Carbon Disulphide by Potassium Hydrate in Absolute Alcohol," is of much practical interest, and as it represents a rapid and expeditious method of eliminating that product from commercial benzol and one on which I have been much engaged during the past six months, I am induced to ask your permission for publication of results that may probably become of much interest to those interested. Considerable attention has already been given to this subject in Germany, and methods have been published both by Luck and Dr. Hoffman, but in their detail they are far too troublesome and costly to find favour or adoption as technical tests. On the other hand, the alcoholic potash method is so simple and rapid in its operation that it may be conducted without increase of ordinary apparatus or extra manipulative skill.

It is well known that a trifling quantity of carbon disulphide, to the extent of 1 or 2 per cent only, constitutes a serious disturbing cause in the ordinary method of benzol testing, causing it to boil low, and with abnormal percentages over at the "85 point," so much so that a really good sample containing it may be suspected and even discredited. The method that I have followed for its removal, and in

which the benzol is placed in its true character, is as follows:—

I usually take about 200 c.c. of the sample under examination, and if of 90 per cent quality, add to it 20 c.c. (10 per cent) of a saturated hot solution of potassium hydrate in absolute alcohol, methylated or otherwise. The mixture is then subjected to frequent agitation during a space of two hours; the potash compound of carbon disulphide rapidly forms and subsides in feathery groups with a silky and glistening appearance. At the expiration of the time named, I filter off the benzol so treated and subject it to two washings with its own bulk of water in a suitable separator; this operation completely removes the alcohol from the benzol. Finally, I run off the wash-water, remove the benzol, and shake it up with a little powdered gypsum (plaster-of-Paris), by which means the suspended and dissolved water is instantly removed, and the benzol left clear and anhydrous.

Presuming the sample operated upon to have been a "light 90 per cent," the difference noticeable will be considerable. First, entire disappearance of previous alliaceous odour; secondly, decrease of gravity from 0·885 to 0·882 or 0·880, varying with quantity of bisulphide originally present and removed; thirdly, disappearance of abnormal boiling-points, falling from 30 per cent or more at the "85 point" to 10 or 12 per cent only. The entire operation may be conducted in the space of two and a half hours, and offers an adjunct to benzol testing, which I think will sooner or later find its recognition. Benzol so treated will be found to boil much closer and to enable a far nearer judgment as to its true composition. Should further verification be required, recourse may be had to method of specific gravity, which with bisulphide absent affords reliable indications. The hydrocarbons associated in commercial benzol are homologous, and as such suffer little alteration from condensation or expansion volume under admixture, and sp. gr. found is pretty nearly the mean of the mixtures.

In following up these results I have compared them with a vast number of mixtures from pure materials of known gravity, and from which I have formulated a set of tables, enabling me to arrive at percentage of benzol, toluol, and xylol (together with carbon disulphide) present in a given sample with certainty. As a further confirmation, I have, through the kindness of Mr. John Browning in furnishing instruments, subjected these samples and admixtures to control, by measurement of refraction angles, and which has furnished results of so much interest that the method alone discriminates mixtures, and quantities hardly possible otherwise, and without resorting either to boiling or specific gravity.

As regards the alcoholic potash method I make no claim whatever to its originality; doubtless others have employed it, although, so far as I am aware, not in the precise way indicated.

In conclusion, I have sometimes thought that a modification of the process might be employed on the large scale for removing bisulphide from commercial benzol, and so cut out the tedious rectification resorted to for that purpose. Ordinary methylated alcohol in lieu of absolute for solution of potash answers nearly as well, but throws out the bisulphide compound in the form of a viscid brown fluid. From the resultant wash-water the surplus alcohol could be recovered by distillation, as in the case of processes resorted to in the manufacture of aniline dyes, and in which methylated alcohol is alternately used and recovered in very considerable quantity, and with little or no loss.

That this product cannot be removed within 1 to 3 per cent by ordinary factory rectification is well known, although as a matter of fact, with those employing the Continental separating or rectifying column (as now in use for the preparation of pure benzol and toluol), the operation becomes certain. The cost, however, of this plant is so heavy that it deters many from adopting it.

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REMARKS ON THE TREATISE OF MR. C. T. KINGZETT:

"Report on the Atmospheric Oxidation of Phosphorus, and some Reactions of Ozone and Hydric Peroxide."*

By Dr. EM. SCHÖNE,

Professor of Chemistry at the Agricultur Academy in Petrowskoye, Rasumowskoye, near Moscow.

Some years ago Mr. Kingzett† disputed the fact that ozone is produced by the slow oxidation of phosphorus, In the latest paper which Mr. Kingzett has published under the title above mentioned, he owns that he was wrong. In the same paper he makes a few statements relative to the estimation of peroxide of hydrogen; these last induce me to make some remarks.

Mr. Kingzett recommends, for the quantitative determination of the peroxide of hydrogen in *dilute* solutions, the addition to the latter of a *very great* excess of *sulphuric* acid (from one vol. up to 5 vols. of acid diluted by 3 parts of water), then potassic iodide in crystals, and starch. After an interval of five minutes the iodine liberated is estimated by titration with the standard thiosulphate of sodium.

After describing several experiments relative to this process, Mr. Kingzett, among the conclusions drawn by him from these experiments, gives the following:—

"Pure neutral peroxide of hydrogen does not decompose potassium iodide with liberation of iodine, although it undergoes spontaneous decomposition."

As to the latter part of this statement, it is certain that peroxide of hydrogen undergoes decomposition, as I have already shown. In regard to the first part—the non-liberation of iodine—I confess that I was surprised when I read this statement, because the experiments pointed out by Mr. Kingzett prove the contrary. On page 804 he says:—

"Experiment 5.—Some of the peroxide solution . . . . was now *neutralised* with pure caustic soda, and to 20 c.c. of this solution was added KI and starch as usual; a trace only of *iodine was set free*, and bubbles of oxygen. . . ."

"Experiment 6.—5 c.c. of a 10 volume solution of hydric peroxide was diluted to 100 c.c., and the solution as nearly as possible *neutralised*. *Iodine was set free* on the addition of KI equal to only 1·8 c.c. N/10 thiosulphate solution, and the same time the solution *became alkaline* to test-paper and *evolved oxygen*." After this I do not understand why Mr. Kingzett enters into polemics with me; for his just-mentioned experiments *confirm* what I myself had found, namely, (1) the liberation of a *small* quantity of iodine; (2) the formation of a corresponding (therefore also a small) quantity of caustic potash; (3) the evolution of oxygen. It is true that in his fourth experiment Mr. Kingzett means that the liberation of iodine depends on the presence of free acid. However, in Experiments 5 and 6 the acid was neutralised, and the liberation of iodine still took place. If during the action of the *neutral* peroxide of hydrogen on a *neutral* potassium iodide caustic potash is formed—which Mr. Kingzett allows unconditionally—what becomes of the iodide of hydrogen corresponding to the produced potash. How can the formation of caustic potash be explained otherwise than by the decomposition of the quantity of hydrogen iodide necessary for its neutralisation, namely, according to the equation $2HI+H_2O_2=2H_2O+I_2$, with liberation of iodine? Mr. Kingzett says—"It occurred to me that, if this acidity were neutralised, peroxide of hydrogen would not liberate iodine from potassium iodide at all." But perhaps Mr. Kingzett had to do in such cases with very dilute solutions of peroxide, wherein the liberation of iodine, indeed, does not begin instantly, but after ten or fifteen minutes, increases slowly, and reaches its maximum only after the lapse of six hours

* *Journal of the Chemical Society*, 1880, i., p. 792.
† Chemical News, vol. xl., p. 96.

In a note on page 805 Mr. Kingzett says that it seems to him an inconsistency that I regard the decomposition of hydrogen peroxide in the presence of potassium iodide as a "catalytic" process, and at the same time allow the liberation of iodine. It is evident that Mr. Kingzett is not acquainted with my original treatise,* but has read only a very short and incomplete abstract of my paper, cited by him (*Jour. Chem. Soc.*, 36, 353). It is true that this gives a wrong idea of my interpretation of the facts. If Mr. Kingzett would give himself the trouble to read my original paper, he would find there the explanation of the seeming inconsistency. In reading it he would likewise understand how the reaction under consideration can be applied to a colorimetric quantitative determination of hydrogen peroxide in solutions which—as, for instance, atmospheric precipitates (rain, snow, &c.)—contain in 1 litre not more than 1 milligrm. of peroxide.

Concerning the above-mentioned method, proposed by Mr. Kingzett himself for the quantitative estimation of the peroxide of hydrogen, it must give very inexact results, especially if one has to do with very dilute solutions of peroxide, for this method has considerable sources of error.

First. It is well known that according to the greater or lesser concentration a greater or smaller quantity of sulphuric acid is decomposed by hydrogen iodide, according to the equation—

$$2HI + H_2SO_4 = H_2O + I_3 + H_2SO_3.$$

Bunsen has stated† that the amount of iodine and sulphurous acid, formed according to this equation, ceases to cause a perceptible error only when the dilution becomes so considerable that 10,000 parts of liquid contain less than 4 parts of sulphuric acid. And Mr. Kingzett operates with *very strongly* acidulated liquids, containing in 10,000 parts about 2000 parts of sulphuric acid—that is, 500 times more than is allowed!

Secondly. It is well known by the researches of V. Harcourt and Esson, that the amount of chemical change occurring at any moment is proportional to the amount of hydrogen iodide and hydrogen peroxide in the solution, the other conditions being the same. Therefore, in very diluted solutions of hydrogen peroxide the reaction is proceeding slowly, and cannot be finished in five minutes. It is true that Mr. Kingzett affirms that five minutes suffice when an abundance of sulphuric acid is added. However, he gives us no proof. On adding to 10 c.c. of a solution of peroxide of hydrogen from 30 to 50 c.c. of sulphuric acid, diluted by 3 parts of water, he found as much iodine (corresponding to 6·3 c.c. 1-10th normal solution $Na_2S_2O_3$) as was liberated "under the most favourable circumstances" (what is the meaning of that?); but this does not prove in the least that *all* the amount of peroxide contained in the solution just mentioned had undergone decomposition. To prove this by evidence is impossible, on account of other sources of error inherent to this method. But even had these sources of error not existed, the author should have at least determined precisely the peroxide of hydrogen in the trial solutions by a more trustworthy method; for instance, by titration with permanganate.

Lastly. Mr. Kingzett's method cannot be precise on account of the circumstance that iodide of hydrogen is decomposed by free oxygen, always to be found in the solutions of peroxide. What considerable errors can be caused by this circumstance, especially in determining the peroxide in very weak solutions; for example, in atmospheric precipitates. This I have already shown elsewhere.‡

In order to demonstrate the inexactness of Mr. Kingzett's method experimentally I will give the following experimental results. The solution of hydrogen peroxide used by me was quite neutral, and the potassium iodide was absolutely free of iodate.*

Experiment I.—A solution of hydrogen peroxide was precisely titrated by permanganate of potassium, and by diluting this a liquid was prepared, containing in 1 litre 1 milligrm. H_2O_2. To 100 c.c. of this liquid were added 400 c.c. of 1:3 sulphuric acid, then about 5 grms. KI in crystals, and 20 c.c. of starch. After five minutes the liberated iodine needed 2·0 c.c. of a solution of sodium hyposulphite, 1 c.c. of which was equal to 0·00605 grm. I, or 0·00081 grm. H_2O_2.

There was thus 0·00162 grm. H_2O_2 found, though in reality there was only 0·0001 grm. Therefore, in making use of Mr. Kingzett's method for the determination of the peroxide of hydrogen in atmospheric precipitates, which (in the neighbourhood of Moscow) only seldom contain more than 1 milligrm. H_2O_2 in 1 litre, *one would find at the least sixteen times more peroxide than is really contained in these precipitates.* This great error is principally the result of the mutual action of HI and H_2SO_4. By substituting for the sulphuric acid another acid not affecting HI—for instance, phosphoric acid—one might have removed *this* source of error, but the others remain. The action of free oxygen on HI especially hinders the precise estimation of peroxide, though in a less degree.

Experiment II. was executed in exactly the same way as Expt. I., with the only difference that for the sulphuric acid was substituted phosphoric acid of corresponding concentration. The liberated iodine needed here only 0·25 c.c. $Na_2S_2O_3$, equal to 0·0002 grm. H_2O_2.

Therefore, notwithstanding this substitution, twice as much H_2O_2 was found as was really taken, depending, as I have already mentioned, on the decomposition of HI by free oxygen contained in the solution.

March 5-17, 1881.

* *Liebig's Annalen der Chemie*, 195, 228-252.
† *Annalen der Chemie und Pharmacie*, 86, 265.
‡ *Zeitschrift für Analytische Chemie*, 18, 149.

* That was the same potassium iodide, the detailed examination of which has been described by me in *Liebig's Annalen*, 195, 234 and 235 in notes.

PHENOL OR CARBOLIC ACID: QUALITATIVE AND QUANTITATIVE TESTS.†

By E. WALLER, Ph.D.

IT is almost unnecessary for me to mention the source from which the carbolic acid is obtained, or the mode in which it is prepared; a brief mention of these points, however, may not here be considered out of place.

The coal-tar contains substances which have been grouped as follows:

Bases.—Ammonia, methylamine, ethylamine, aniline, quinoline, picoline, pyrridine, toluidine, &c.

Acids.—Acetic, rosolic, and brunolic, &c., with what are really phenols, though they have been called acids, carbolic acid, or phenol, cresol, phlorol, thymol, &c.

Neutral Substances.—Benzene, toluene, cumene, cymene, —liquids; anthracene, chrysene, pyrene—solids.

In this country the method of obtaining commercial carbolic acid or crude phenol is usually as follows:—The portion called the "light oil" is distilled off at temperatures below 350° or 400° F. Steam is then passed through this light oil until no more of the oil can be carried off in this way. The mixed steam and vapour is condensed, the latter affording what is known as "refined coal-tar naphtha," and consisting of (benzol) benzene with some admixture of (toluol) toluene. What has not been volatilised by use of the steam is known as "naphtha tailings" and contains the most of the phenol in the original coal-tar. In England a somewhat different method is employed. A fraction coming off at lower temperature is first distilled off for the naphtha and the residue is treated for phenol. In either case the phenol is obtained by agitating the material with an aqueous solution of some fixed alkali, and after

† Reprinted from the *School of Mines Quarterly*, for Jan., 1881.

separating the alkaline solution from the oil which does not dissolve, neutralising the alkali with an acid, which liberates the phenol.*

As carbolic acid or phenol is often called coal-tar creosote, and indeed resembles creosote in many respects† it is often necessary to distinguish between the two, or to detect any addition of the former to the latter.

The tests most relied upon for this purpose are—

1. The solubility of the sample in glycerine‡ (Gr. 1·258.)

Carbolic and cresylic acids (phenol and cresol) will dissolve, while creosote does not, at least unless less than half the sample consists of creasote.

2. The action with collodion. Creosote does not coagulate collodion (precipitate the nitro-cellulose) while phenol does.

3. The effects produced by addition of a few drops of ferric chloride to their aqueous solutions. Creosote gives a brownish yellow colouration, while phenol gives a bluish violet.§

Fluckiger‖ tests for the presence of phenol in creosote by warming a water solution of the sample with one-fourth its volume of ammonia hydrate, wetting the inside of a porcelain dish with this solution, and then blowing fumes of bromine upon the surface of the dish. In presence of phenol a fine blue colour appears. Creosote gives only a dirty green or brown. The test requires care to avoid excess of bromine, which spoils the reaction.

Still another test is that with a splinter of pine wood,¶ which is first dipped in a water solution of the sample, and then in concentrated hydrochloric acid. In the course of half an hour the wood assumes a bluish colour if carbolic acid were present—at least such is the statement, but it has been found that concentrated hydrochloric acid alone will produce this effect, and the test has been abandoned as untrustworthy.

With regard to tests for phenol, independent of comparison with creosote, various tests have been proposed or used. The principal ones are as follows :—

*Ammonia and Hypochlorite.***—On adding to a water solution of phenol about one-quarter its volume of ammonia hydrate, and then a solution of bleaching-powder or some hypochlorite, a fine bluish green colouration develops—rapidly, if heat is applied.†† This is said to detect one part of phenol in 3000. The reaction has been used per contra as a test for ammonia, and for that purpose is tolerably delicate.

Nitric acid.‡‡—The addition of nitric acid to a solution containing phenol gives (especially on warming) a yellow colouration, due to the formation of picric (trinitrophenic) acid.

One part of phenol in 6000 may thus be detected but as nitric acid yields picric acid or other compounds having a yellow colour, with various organic substances, the test cannot be considered as very distinctive.

Mercury Nitrates.§§—Millon's reagent, &c. Solutions of mercury in nitric acid, affording mercurous or mercuric nitrates (one or both) containing some nitrous acid, have been proposed by different experimenters. Millon's reagent is a solution of mercury in fuming nitric acid. The addition of a solution of this kind to a water solution of phenol gives in a short time a strong blood red tint resembling the reaction of sulphocyanides with ferric salts. The reaction is hastened by the application of heat. The reaction is said to be perceptible when only one part of phenol in 200,000 is present.

*Concentrated Sulphuric Acid.**—On pouring a solution containing phenol upon the surface of concentrated sulphuric acid in such a way that the liquids do not mix, the zone between them takes a greenish or bluish tint, becoming finally red. One part in 2000 is said to be perceptible by this test. The colours, however, are very delicate, and take some time to develop. Since different intensities of tint may be obtained with different qualities of sulphuric acid, the reaction may possibly be due to some impurities in the acid, perhaps nitrogen oxides.

Molybdic Acid in Concentrated Sulphuric Acid.†—The addition of conc. sulphuric acid containing ten per cent of molybdic acid in solution to a solution of phenol gives at first a bluish tint, which in a short time passes to reddish violet. The test is best performed in a white porcelain dish.

The reaction is said to serve for the detection of small amounts of phenol in creosote.

Potassic Dichromate with Concentrated Sulphuric Acid.‡—Pollacci highly recommends this test, which is performed in a similar manner to the last. The colouration produced is brown. The delicacy of the test is put at one part in 3000. The colouration is apparently due to the partial reduction of the chromic anhydride formed, and it might be anticipated that other organic compounds would give the same or a similar reaction. The test is but little used.§

Euchlorine Test.‖—This is thus described :—

In a five inch test-tube put ten grains powdered potassium chlorate, pour on concentrated hydrochloric acid to the depth of one inch; allow the evolution of gas to proceed for half a minute. Dilute with one and a half volumes of water and remove the gas by blowing through a bent tube. Pour in ammonia so as to form a layer on the top. Blow out the ammonium chloride fumes, and add a few drops of the sample, In the presence of phenol, the ammonia layer assumes a rose-red, blood-red, red-brown, or dark-brown tint, according to the amount of phenol present. One part in 12,000 gives the reaction.

Ferric Chloride.—The addition of ferric chloride to a solution containing phenol gives a fine bluish violet colouration. The reaction is materially interfered with by the presence of acids or neutral salts, and with water solution from crude samples it alters rapidly; usually to a dirty greenish hue.

Bromine Water.¶—This test is readily applied. The addition of bromine water to a solution containing phenol gives a whitish curdy precipitate of tribromphenol, which re-dissolves in the solution of phenol when but little of the bromine water has been added; a further addition renders the precipitate permanent. The delicacy of this test is one part in 43,700 (Landolt) one in 15,500 (Pollacci** and Locatell.) The precipitate is soluble in ether, alcohol, carbon disulphide, and the most of that class of solvents, as well as in alkaline solutions. The homologues of phenol, as well as aniline, toluidine, quinine, morphine, &c., give a similar precipitate. In contact with sodium amalgam the tribromphenol is re-converted into phenol, which may be recognised by its odour.

The cinchona alkaloids have also been proposed as tests for phenol.††

The odour of phenol is said to be perceptible to the extent of one part in 2800.‡‡

As quantitative tests for phenol the degree of solubility

* *Vide* "Commercial Organic Analysis." By A. H. Allen. Vol. i., note to p. 305.

† Creosote consists of a mixture of guaiacol, $C_7H_8O_2$, and creasol, $C_8H_{10}O_2$, while phenol is C_6H_6O. *Vide* Brauninger, *Jour. Lond. Chem. Soc.*, 1878, p. 2, 146.

‡ T. Morson, *Jour. de Pharm. et de Chem.*, Dec., 1872.

§ *Vide* Böttger, *Pharm. Centralhalle*, xvii., 284.

‖ *Arch. der Pharm.*, cciii., 30.

¶ "U.S. Dispensatory," 13th ed., p. 342.

** R. Lex, *Berichte der Deutschen Chem. Gesell.*, iii., 457. Cotton, *Bull. Soc. Chim. de Paris*, xxi., No. 1. Salkowski, *Archiv. der Physi l*, v., 353.

†† *Vide* Jacquemin, *Archiv. der Pharm.*, cciii., 47. Aniline with hypochlorite used.

‡‡ Pollacci, *Gaz. Chim. Ital.*, iv., 8.

§§ Plugge, *Frcs. Zts f. Anal. Chem*, xi., 173. Fluckiger, *Archiv. der Pharm.*, cclii., 30. Pochl, *Pharm. Zts. f. Russland*, xvi., 547.

* Pollacci, *Gaz Chim. Ital*, iv., 8.

† Davey, *Polyt. Notizblatt*, 1878, 300. *Vide* Fröhde, *Zts. Allg. Oesterr. Apotheker-ve ein*, September 20, 1873.

‡ *Ber. d. Chem. Gessell.*, vii., 360. *Gaz. Chim. Ital.*, iv., 8.

§ Tasca Lanza, *Gaz. Chim. Ital.*, iv.

‖ C. Rice, *Am. Jour. Pharm.*, March, 1873, p. 98.

¶ Landolt, *Ber. d. Chem. Ges.*, iv., 770.

** *Gaz. Chim. Ital.*, iv., 8.

†† Hesse, *Liebig's Ann. Chem.*, clxxxi., Heft 1.

‡‡ Landolt, *loc. cit.*

For comparison of the relative delicacy of these different tests see Landolt, *loc. cit.* Pollacci, *loc. cit.*, and Almen, *Archiv. der Pharm.*, vii., 44.

of a sample in water or in alkaline solutions,* and the ferric chloride† test have been used until quite recently. The two first methods consist of simply shaking up a measured amount of the sample with sufficient water or alkaline solution to dissolve it, were it all phenol, and measuring the amount of oil undissolved.

With pure water there exists the practical difficulty that the insoluble portion will partly rise to the top, partly sink to the bottom, and part again stick to the sides. Acting on Prof. Chandler's suggestion, I have used a measured quantity of olive oil with the sample, which will mix with the impurities, and in this way tolerably good results may be obtained. The oil, however, should not be added until the sample has been thoroughly shaken up with the water, since otherwise it will hold back some of the phenol, and prevent its solution in the water. Making the test with a solution of a fixed alkali presents fewer difficulties, but some of the impurities which are not phenol will also dissolve in the alkaline solution and give too high results. In either case the results are usually too high, since the crude phenol may hold a considerable quantity of water, which by this method is reckoned as phenol.

The ferric chloride test is a colorimetric test, and is performed by making a solution of the sample (10 grms. in 1 litre, for instance) filtering to clear it, and then comparing the colour obtained in 10 c.c. of this solution by the addition of two or three drops of ferric chloride, with the colour obtained in solutions of phenol of known strength, with the same amount of that reagent. The difficulty with the test is that solutions of the crude samples often afford a very different colour from that obtained with pure phenol, and moreover, in almost all cases the colour alters so rapidly as to give great difficulty in making a satisfactory estimation. Moreover, the test cannot be applied in testing carbolates of lime or similar preparations.

Taking the reaction described by Landolt (the precipitation of phenol by bromine) I have succeeded in obtaining what I believe to be a reliable method for the quantitative estimation of phenol. The results were obtained in 1873, and published the next year, not, however, in what I have heard called "the current of chemical literature," so that processes based upon this reaction have since been published‡ which has given the authors the claim of priority in the matter. The method which I used is, however, somewhat simpler than the others.

The solutions necessary are:

1. A solution of 10 grms. pure crystallised phenol in 1 litre of water. This solution serves as the standard with which to compare the results obtained on the samples analysed. The solution will keep for some months without alteration.

2. Solution of bromine in water. In practice it has been found convenient to keep on hand two bottles, one with the bromine in the bottom, the other for the solution when it becomes sufficiently saturated.

3. Solution of alum in dilute sulphuric acid. Dilute sulphuric acid containing about 100 c.c. concentrated sulphuric acid in the litre is shaken with alum crystals until saturated.

The use of this solution is to aid in the ready separation of the bromine precipitate, by making it more dense, and by insuring the necessary acidity of the solution. The sulphuric acid also holds more alum in solution than pure water, which is an advantage. This solution is not absolutely indispensable, but in using it the analysis usually works more smoothly.

The process is conducted as follows:—10 grms. of the sample are weighed out and then run into a litre flask, water added, and the mixture shaken, the flask being finally filled up to the mark. After thorough mixing, some of the solution is filtered through a dry filter, and 10 c.c. of the clear solution is run into a six or eight oz. reagent bottle, fitted with tight fitting glass stopper, about 30 c.c. of the alum solution is added, and in a similar bottle 5 or 10 c.c. of the standard phenol solution are placed, also with about 30 c.c. of the alum solution. A burette is now filled with the solution of bromine, and from this the reagent is run into the bottle containing the standard solution of phenol until no more precipitate forms. The bottle must be stoppered and shaken after the addition of every few c.c. Toward the end of the reaction the precipitate forms rather slowly, and when the phenol has been saturated a very slight excess of bromine gives a yellow tint to the solution. Shaking the bottle causes the precipitate to separate readily, leaving the solution clear. The bromine water is usually taken of such a strength that about 30 c.c. are required to precipitate the phenol from 10 c.c. of the standard solution.

The solution from the sample is treated in the same way, and from the amount of bromine water required for each respectively the percentage in the sample may be readily calculated. *E.g.*, if 5 c.c. of the standard required 15 c.c. bromine water, and 10 c.c. of solution of the sample took 17 c.c., the calculation would be

$$(15 \times 2) : 17 = 100 : x \text{ per cent.}$$

If, in weighing out, 10·25 grms. instead of 10 grms. had been taken, this result would have to be divided by 1·025 to get the true percentage.

As the precipitate rises to the top instead of settling to the bottom, it will be found convenient to use a small glass tube, a little longer than the bottle and flared at the top in funnel form, through which the bromine may be introduced into the clear solution. The bromine water held in the tube by capillary attraction can be gently blown into the solution without inconvenience to the operator.

With most of the samples of commercial phenol "carbolic acid" the precipitate will not readily separate from the solution even by prolonged shaking. The solution may be at once cleared, however, by adding to it some of the precipitate already obtained by testing the standard phenol solution and shaking up.

The end reaction is when the further addition of bromine water fails to produce any precipitate. With pure phenol the solution only assumes a yellow colour when an excess of the bromine is present, but with many of the commercial samples the solution has a yellow tint from the start, which, however, does not appear to deepen until the phenol or its homologues are saturated. The effect of the bromine upon the homologues of phenol, as cresol, phlorol, &c., is probably the same, and in conducting an analysis by this method, those substances are reckoned as phenol. The absence of aniline, toluidine, and similar bases which may be present in the coal-tar should be insured, as those bases also react in a similar manner with the bromine water. Usually the mode of preparing the commercial carbolic acid by means of alkaline solutions precludes this source of error; with a dead oil, however, the sample requires a preliminary treatment with solution of some fixed alkali to remove them.

The bromine water does not of course keep the same standard throughout, but during a morning's work it varies very little. Until the solution gets low in the bottle, every other burette full seldom gives a variation greater than 0·1 to 0·2 c.c. on 10 c.c. of standard phenol solution. Unless the bromine water is allowed to stand in the burette for some time, the last portions have the same standard as the first.

The other quantitative methods using this reaction with bromine are somewhat more elaborate, an excess of bromine water being used, and the excess being titrated with sodium hyposulphite or detected by iodised starch paper. A stronger solution of bromine also is used, and the methods, though the same in principle, are quite different in detail.

* Ott, *Dingler's Polyt. Journ.* clxxxvi., 148. See also H. Muller' *Zts. f. Chem.*, N.F. i., pp. 271 *et seq.* H. Hager, *Pharm. Centralhalle*, No. 5, 1872.

† Leube, *Wittstains Vierteljahresschrift f. Pharm.*, xx., 574. *Dingl. olyt. Jour.*, ccii.

‡ Koppeschar, *Fres. Zts. f. Analyt. Chem*, xv., 233. Degener, *Journ. f. Prakt. Chem.*, N. F., xvii., 390.

NOTICES OF BOOKS.

Recueil des Travaux Chimiques du Dr. Domingos Freire. Rio de Janeiro: Molarinho and Mont'Alverne.

This volume consists of a number of memoirs on chemical and micro-biological subjects. They are respectively entitled:—Notice on the colouring matter of *Solanum nigrum*, and on an animalcule developed in the juice of the plant; experiments on the part played by the gases of urine; points of contact between homology, molecular weight, and density in reference to water; on an aldehyd isomeric with ordinary acetaldehyd; chemical analysis of one of the springs of the Gamboa; examination of a linseed sophisticated with resin oils and other impurities; reflections on the part played in chemistry by weight, volume, and number; study on pereirine; researches on a cryptogamous plant; the cause of the oxidation of oils; influence of chemical agents on oily fermentation; on vieirine; on the action of oxidising agents upon natural alkaloids; a new calculation for finding the molecular weight, the vapour-density being known; and researches on the rancidification of butter. The last, and probably the most important, paper, "On the Cause, Nature, and Treatment of Yellow Fever," is of a medical rather than of a chemical nature. The author has discovered in the blood of persons suffering from this disease a figured and organised ferment which attacks and destroys the blood globules. He seeks to destroy this enemy by the hypodermic injection of solutions of sodium salicylate. He considers that these microbia are introduced through the digestive organs, especially as he has found both in butter and in the milk of the cocoa corpuscules similar to those detected in the blood of yellow fever patients. He observes that electric action in the atmosphere gives greater activity to the multiplication of the ferment, just as it stimulates the development of higher plants. Thunderstorms have a most disastrous influence both on the virulence and the spread of the fever. This fact may be taken into account by those who still uphold the sanitary influence of ozone, since this body is always considered to be produced by electric action in the atmosphere.

The rancidity of butter he considers due to the development of cryptococci which live at the expense of the caseine and of the complex mixture of fatty ethers which form butter. Hence he pronounces the use of such butter unsafe, it being a mass of microscopic vegetation.

The oxidation of oils he finds is in like manner due not to the mere action of oxygen, but to a fungus which he names *Microclados oleorum*. This microphyte cannot develop in oils containing phenol, arsenious acid, or copper sulphate. It will be seen that Dr. Freire is zealously contributing to work out the mine of discovery which has been opened by Pasteur. This class of research is particularly interesting, as lying on the boundary line between chemistry and biology, and as enriching both these sciences at once. As regards the practical applications of the new theory of ferments, it may surely be said that if Dr. Freire's proposal for the treatment of yellow fever is confirmed by further experience he will be entitled to rank among the greatest benefactors of the human race.

CORRESPONDENCE.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

Sir,—Will you kindly allow me a small space to ask "F.I.C." what fault he finds in the terms of the question (set at the late Natural Science Studentship at Christ Church) to which he refers in last week's Chemical News.—I am, &c.,

H. B. Dixon.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Justus Liebig's Annalen der Chemie, Heft 2, 1880.

Decomposition- and Transformation-Products of Uranyl-sulphide.—Clemens Zimmermann.—The metals of the so-called ammonium sulphide group display a varying permanence in their compounds, decreasing from zinc sulphide through cobaltous, nickelous, manganous, and ferrous sulphide, and becoming slightest in the sulphur compound of uranium. The last metal may be regarded as a connecting link between those metals which are precipitated by ammonium sulphide as sulphides, and such as are precipitated as hydroxides, just as lithium forms the transition between the alkalies and the alkaline earths. Zinc, nickel, and cobalt, whose oxides are less numerous, retain sulphur more firmly than manganese or iron. Uranium, which according to our present knowledge forms no fewer than nine oxides, has the slightest affinity for sulphur. This is especially manifested in the uranyl salts, which, even in their sulphides, retain oxygen. Remelé mentions that uranyl sulphide is partially soluble in ammonium sulphide, which, according to the author, is due to the presence of carbonic acid. Ammonium carbonate and the carbonates of the fixed alkalies prevent the precipitation of the uranyl salts by ammonium sulphide, or re-dissolve the precipitate if they are added subsequently. If uranyl sulphide is heated to 40° or 50° with the supernatant liquid containing ammonium sulphide till the latter is decomposed, there results a grey-black mixture of uranous oxide and sulphur, whilst the liquid becomes perfectly limpid. This behaviour of uranyl sulphide has been utilised for the separation of uranium from the alkalies. The author has satisfied himself that this method is trustworthy, the uranyl sulphide being completely resolved into uranous oxide and sulphur. Precipitated uranium sulphide, on prolonged contact with ammonium sulphide in the cold, undergoes changes. The chocolate-coloured substance under certain circumstances becomes either red or black. The former if allowed to stand in contact with the precipitant from twenty-four to forty-eight hours in the cold with access of air gives a splendid blood-red body, "uranium-red." If the air is excluded, and if the ammonium sulphide is free from hyposulphites, a black compound is formed. The formula of the black product is probably $3Ur_2O_3 + UrO$. That of uranium-red is probably $Ur_6SK_2O_9$.

Reaction of the Uranyl Salts with Turmeric Paper.—Clemens Zimmermann.—Soluble uranyl salts colour blue litmus slightly reddish, and turmeric paper more or less brown, even if the solutions are very dilute. The brown colour produced is intermediate between that caused by alkalies and that given by boric acid. From the reaction of the former it is distinguished by its production in slightly acid solution, and from the latter by the fact that it disappears on the addition of free mineral acids, and is prevented by the presence of an excess of acetic acid. The brown colour is further converted to a violet-black if the paper is touched with dilute sodium carbonate, and the original yellow of the turmeric paper is restored by subsequently moistening with hydrochloric acid. The brownish red colour produced by boric acid is, according to Vogel and Ludwig, turned blue or black by sodium carbonate, and re-converted to a reddish brown by hydrochloric acid.

Separation of the Heavy Metals of the Ammonium Sulphide Group.—In vol. 199, p. 1, the author gave a method of separating zinc from the remaining metals of the group based on the insolubility of zinc sulphide in dilute hydro-sulphocyanic acid. As an essential precau-

tion he recommended accurate neutralisation of the liquid, which is then mixed with ammonium sulphocyanide and saturated with hydrogen sulphide. He has subsequently applied directly and successively hydro-sulphocyanic acid, which he obtains as follows:—2 parts basic sugar of lead are precipitated with 1 part ammonium sulphocyanide, keeping the flask continually shaken. The lead sulphocyanide thus obtained is washed with cold water, decomposed with hydrogen sulphide, agitating from time to time, and freed from lead sulphide by filtration. Hydrogen sulphide is expelled from the liquid by blowing in air.

Hydrolytic Actions of the Pancreas, Duodenum, Jejunum, and Ileum.—H. T. Brown and J. Heron.—The action of artificial pancreatic juice upon starch-paste at 40° is, in the first stages of the reaction, equal to that of unheated extract of malt at 60°; the composition of the starch products in both cases undergoes no further notable change when 80·8 per cent of maltose have been formed. Pancreatic diastase is capable of slowly converting maltose into dextrose—a change which malt-diastase is incapable of producing. Neither artificial pancreatic juice nor the tissue of the gland itself contains any ferment capable of inverting cane-sugar. The lesser intestines can invert cane-sugar, hydrolise maltose, and effect slightly the transformation of starch.

Vapour Tensions of Homologous Series and Kopp's Law of Constant Differences of Boiling-Points.—A. Winkelmann.—The direct examination of Kopp's law, based upon the observations of Landolt, does not warrant a denial of the general applicability of the law.

Heft 3, 1880.

The Distribution of Atoms in the Molecule.—W. Lossen.—This treatise, which fills up the entire number, does not admit of fair abstraction in the space at our disposal. The author criticises the views of Kekulé, Kolbe, Naumann, L. Meyer, O. E. Meyer, and Mendelejeff. He remarks that we must in the first place represent to ourselves what masses exist within the space of the molecule. It is especially Kekulé's merit to have cautioned chemists not to be content with the contemplation of a divisible mass within the molecule, and that the action of every single indivisible mass, every atom, must be investigated. It does not seem to have been sufficiently considered that the action of the indivisible mass emanates from the *whole* indivisible mass. In consequence of the neglect of this principle, we ascribe to fractions of the atoms an efficacy which can only be ascribed to the atoms themselves, and we turn away our attention from the distribution of the atoms in space.

MISCELLANEOUS.

Royal Agricultural College, Cirencester.—The approaching vacancy in the Chair of Theoretical and Agricultural Chemistry at this College has been filled by the appointment of Professor Edward Kinch, F.C.S., F.I.C., &c., Professor of Chemistry in the Imperial College of Agriculture, Tokio, Japan. Professor Kinch has already been connected with the College, having for three and a half years been Senior Assistant there to Professor Church, where he earned the respect and attachment of Professors and Students by his patient and able teaching, and genial qualities. Subsequently for three years he held the post of Demonstrator, under Dr. Frankland, at the Royal College of Chemistry, and was for a year Superintendent of the Mineral Department, and Chemist to the Indian Museum. He was recommended to the Japanese Government for the Professorship of General and Agricultural Chemistry in the Imperial College, which office he has now held for four years. He has exercised a powerful and beneficial influence over the large number of Students who have passed under his charge, both in this country and Japan, and is known to be an efficient practical teacher, a successful lecturer, and agreeable collaborateur. The resignation of his post in Japan has been received by the Government and Students with great regret, and it is arranged that he will enter upon his duties at the Royal Agricultural College, at the opening of the ensuing Session in May next.

Society of Chemical Industry.—The inaugural meeting of the above proposed Society will be held in the rooms of the Chemical Society, Burlington House, Piccadilly, London, W., on Monday, April 4th, at four o'clock in the afternoon. This Society is not intended to represent any one particular branch of Chemical Industry. It is hoped that it will be representative of many manufactures—Alkali-making, Manure-making, the Textile Colour industries, the Glass and Pottery manufactures, Tar Distilling, Soap-making, Sugar-making, Brewing, Metallurgy, the manufacture of fine Chemicals, and all other industries which show any connection with Chemical Science.

At the last general meeting of the Sub-Committee, held at the Owens College, Manchester, on December 4, 1880, it was resolved that a Society of Chemical Engineers be established, and a Sub-Committee was appointed to make preparations for this meeting, and for considering the details of the scheme. It is not necessary to go into particulars: suffice it to say that for some time the want of a Society has been felt, the object of which is the advancement of Manufacturing Chemistry in the United Kingdom. In order to accomplish this it is desirable to establish a Society which may be the means of bringing together, at stated intervals, all those who possess chemical, physical, and engineering knowledge, and who use this knowledge in the utilisation of chemical action on a manufacturing scale, and who have the charge of, or an interest in, chemical industries. It may indeed prove afterwards desirable to found a distinct branch of the Engineering Profession, to be composed of persons who possess the aforesaid knowledge, and who may be designated as Chemical Engineers. It is unnecessary to state the advantages which would doubtless accrue to the various branches of chemical industry by the training in all chemical, physical, and engineering matters connected with the business, of all those who have charge of processes; but independent of this, such a Society as is proposed to be established would have certain objects in view, which may be briefly stated as follows:—

To enable persons interested in Chemical Industries to meet, to correspond, and interchange ideas respecting improvements in the various processes. To publish information relating to the aforesaid, by means of a *Journal* or otherwise. To acquire and dispose of property for such purposes, and to do all other things incidental or conducive to the above-named objects, or any of them.

It is proposed that the Society shall consist of Members, Associates, Students, and Honorary Members. Members may consist of persons who by their attainments may be considered by the Council to be eligible. Associates may consist of persons practically engaged in such matters, and considered by the Council and Local Committees to be eligible. Students may be those who are disqualified by age or otherwise from election as Members or Associates. Honorary Members must be selected by reason of their distinction in matters relating to Chemical Industry.

It is proposed to hold Annual General Meetings at such times and places as may be decided upon at each Annual Meeting, and further, it is proposed to organise district or local sections, branches of the parent Society, at which Members and Associates may meet oftener and more conveniently than would be possible if only Annual Meetings were held.

A resolution will be proposed at the meeting to this effect:—"That all who subscribe their names to the memorandum shall be admitted as first members of the Society without the payment of any entrance fee."

NOTES AND QUERIES.

**** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Patent D yers.—In reply to "L. A.," in yours of the 25th, the article used for patent dryers is ground sulphate of manganese. It ought not to contain naturally barium and calcium carbonate.—GEO. G. BLACKWELL.

MEETINGS FOR THE WEEK

MONDAY, 4th.—Medical, 8.30.
— Royal Institution. General Monthly Meeting, 5.
— Society of Arts, 8. "The Art of Lace-making," Alan S. Cole.
TUESDAY, 5th.—Royal Institution, 3 p.m. "The Blood," Prof. Schäfer.
— Civil Engineers, 8.
— Society of Arts, 8. "Canada; the Old Colony and the New Dominion," E. Hepple Hall.
— Chemical, 8.30. Faraday Lecture. "On the Modern Development of Faraday's Conception of Electricity," Professor Helmholtz (To be given in the Theatre of the Royal Institution, Albemarle Street).
WEDNESDAY, 6th.—Society of Arts, 8. "The Discrimination and Artistic Use of Precious Stones," Professor A. H. Church, F.C.S.
— Geological, 8.
— Pharmaceutical, 8.
THURSDAY, 7th.—Royal, 4.30.
— Chemical, 8. "On the Estimation of Hydric Peroxide by means of Potassic Permanganate," W. E. Admey. "On the Action of Compounds Inimical to Bacterial Life," William M. Hamlet.
— Royal Institution, 3. "Ornament," Mr. H. H. Statham.
FRIDAY, 8th.—Royal Institution, 8. "Conversion of Radiant Heat into Sound," Prof. Tyndall, 9.
— Quekett, 8.
SATURDAY, 9th.—Royal Institution, 3. "American Humourists," Rev. H. R. Haweis.
— Physical, 3. "Note on Thermal Electrolysis," Dr. J. H. Gladstone and Mr. Tribe.

TO CORRESPONDENTS.

J. W. O'Neill.—See notice at the head of our "Notes and Queries" column. We do not know the address of "Olive Oil."

E. L. Marks.—Application must be made to the Secretary of the Chemical Society, Burlington House, Piccadilly, London.

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SOLAR PHYSICS.

The following Courses of Lectures will be given by Members of the Committee on Solar Physics, appointed by the Lords of the Committee of Council on Education:—

An Introductory Lecture. By Professor STOKES, Sec. R.S. 6th April, 1881.

A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena. By Lieut.-General STRACHEY R.E., C.S.I., F.R.S. 8th April.

Two Lectures on the Connection between Solar and Terrestrial Phenomena. By Professor BALFOUR STEWART, F.R.S. 27th and 29th April.

Six Lectures on Spectroscopy in Relation to Solar Chemistry. By Mr. J. NORMAN LOCKYER, F.R.S. 4th, 6th, 11th, 13th, 18th, and 20th May.

Three Lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics. By Captain ABNEY, R.E., F.R.S. 25th and 27th May and 1st June.

The Lectures will be delivered in the Lecture Theatre of the South Kensington Museum, at 4 p.m., on the days stated above.

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ON THE MODERN DEVELOPMENT OF FARADAY'S CONCEPTION OF ELECTRICITY.*

By Professor HELMHOLTZ.

Mr. President, Ladies, and Gentlemen,—

The majority of Faraday's own researches were connected, directly or indirectly, with questions regarding the nature of electricity, and his most important and most renowned discoveries lay in this field. The facts which he has found are universally known. Nevertheless, the fundamental conceptions by which Faraday has been led to these much-admired discoveries have not been received with much consideration. His principal aim was to express in his new conceptions only facts, with the least possible use of hypothetical substances and forces. This was really a progress in general scientific method, destined to purify science from the last remnants of metaphysics. Now that the mathematical interpretations of Faraday's conceptions regarding the nature of electric and magnetic force has been given by Clerk Maxwell, we see how great a degree of exactness and precision was really hidden behind his words, which to his contemporaries appeared so vague or obscure; and it is astonishing in the highest to see what a large number of general theories the methodical deduction of which requires the highest powers of mathematical analysis, he has found by a kind of intuition, with the security of instinct, without the help of a single mathematical formula.

The electrical researches of Faraday, although embracing a great number of apparently minute and disconnected questions, all of which he has treated with the same careful attention and conscientiousness, are really always aiming at two fundamental problems of natural philosophy, the one more regarding the nature of physical forces, or of forces working at a distance; the other, in the same way, regarding chemical forces, or those which act from molecule to molecule, and the relation between these and the first.

The great fundamental problem which Faraday called up anew for discussion was the existence of forces working directly at a distance without any intervening medium. During the last and the beginning of the present century the model after the likeness of which nearly all physical theories had been formed was the force of gravitation acting between the sun, the planets, and their satellites. It is known how, with much caution and even reluctance, Sir Isaac Newton himself proposed his grand hypothesis, which was destined to become the first great and imposing example, illustrating the power of true scientific method.

But then came Oerstedt's discovery of the motions of magnets under the influence of electric currents. The force acting in these phenomena had a new and very singular character. It seemed as if it would drive a single isolated pole of a magnet in a circle around the wire conducting the current, on and on without end, never coming to rest. Faraday saw that a motion of this kind could not be produced by any force of attraction or repulsion, working from point to point. If the current is able to increase the velocity of the magnet, the magnet must react on the current. So he made the experiment, and discovered induced currents; he traced them out through all the various conditions under which they ought to appear. He concluded that somewhere in a part of the space traversed by magnetic force there exists a peculiar state of tension, and that every change of this tension produces electromotive force. This unknown hypothetical state he called provisionally the electrotonic state, and he was occupied for years and years in finding out what was this electrotonic state. He discovered at first, in 1838, the dielectric polarisation of electric insulators, subject to electric forces. Such bodies show, under the influence of electric forces, phenomena perfectly analogous to those exhibited by soft iron under the influence of the magnetic force. Eleven years later, in 1849, he was able to demonstrate that all ponderable matter is magnetised under the influence of sufficiently intense magnetic force, and at the same time he discovered the phenomena of diamagnetism, which indicated that even space, devoid of all ponderable matter, is magnetisable; and now with quite a wonderful sagacity and intellectual precision Faraday performed in his brain the work of a great mathematician without using a single mathematical formula. He saw with his mind's eye that by these systems of tensions and pressures produced by the dielectric and magnetic polarisation of space which surrounds electrified bodies, magnets or wires conducting electric currents, all the phenomena of electro-static, magnetic, electro-magnetic attraction, repulsion, and induction could be explained, without recurrring at all to forces acting directly at a distance. This was the part of his path where so few could follow him; perhaps a Clerk Maxwell, a second man of the same power and independence of intellect, was necessary to reconstruct in the normal methods of science the great building, the plan of which Faraday had conceived in his mind and attempted to make visible to his contemporaries.

Nevertheless the adherents of direct action at a distance have not yet ceased to search for solutions of the electro-magnetic problem. The present development of science, however, shows, as I think, a state of things very favourable to the hope that Faraday's fundamental conceptions may in the immediate future receive general assent. His theory, indeed, is the only existing one which is at the same time in perfect harmony with the facts observed, and which at least does not lead into any contradiction against the general axioms of dynamics.

It is not at all necessary to accept any definite opinion about the ultimate nature of the agent which we call electricity.

Faraday himself avoided as much as he could giving any affirmative assertion regarding this problem, although he did not conceal his disinclination to believe in the existence of two opposite electric fluids.

For our own discussion of the electro-chemical phenomena, to which we shall turn now, I beg permission to use the language of the old dualistic theory, because we shall have to speak principally on relations of quantity.

I now turn to the second fundamental problem aimed at by Faraday, the connection between electric and chemical force. Already, before Faraday went to work, an elaborate electro-chemical theory had been established by the renowned Swedish chemist, Berzelius, which formed the connecting-link of the great work of his life, the systematisation of the chemical knowledge of his time. His starting point was the series into which Volta had arranged the metals according to the electric tension which they exhibit after contact with each other. A fundamental point which Faraday's experiment contradicted was the supposition that the quantity of electricity collected in each atom was dependent on their mutual electro-chemical differences, which he considered as the cause of their apparently greater chemical affinity. But although the fundamental conceptions of Berzelius's theory have been forsaken, chemists have not ceased to speak of positive and negative constituents of a compound body. Nobody can overlook that such a contrast of qualities, as

* The Faraday Lecture, delivered before the Fellows of the Chemical Society in the Theatre of the Royal Institution, on Tuesday, April 5th, 1881, by Professor Helmholtz. Abstract revised by the Author.

was expressed in Berzelius's theory, really exists, well-developed at the extremities, less evident in the middle terms of the series, playing an important part in all chemical actions, although often subordinated to other influences.

When Faraday began to study the phenomena of decomposition by the galvanic current, which of course were considered by Berzelius as one of the firmest supports of his theory, he put a very simple question; the first question, indeed, which every chemist speculating about electrolysis ought to have answered. He asked, What is the quantity of electrolytic decomposition if the same quantity of electricity is sent through several electrolytic cells? By this investigation he discovered that most important law, generally known under his name, but called by him the law of definite electrolytic action.

Faraday concluded from his experiments that a definite quantity of electricity cannot pass a voltametric cell containing acidulated water between electrodes of platinum without setting free at the negative electrode a corresponding definite amount of hydrogen, and at the positive electrode the equivalent quantity of oxygen, one atom of oxygen for every pair of atoms of hydrogen. If instead of hydrogen any other element capable of substituting hydrogen is separated from the electrolyte, this is done also in a quantity exactly equivalent to the quantity of hydrogen which would have been evolved by the same electric current.

Since that time our experimental methods and our knowledge of the laws of electrical phenomena have made enormous progress, and a great many obstacles have now been removed which entangled every one of Faraday's steps, and obliged him to fight with the confused ideas and ill-applied theoretical conceptions of some of his contemporaries. We need not hesitate to say that the more experimental methods were refined, the more the exactness and generality of Faraday's law was confirmed.

In the beginning Berzelius and the adherents of Volta's original theory of galvanism, based on the effects of metallic contact, raised many objections against Faraday's law. By the combination of Nobili's astatic pairs of magnetic needles with Schweigger's multiplicator, a coil of copper wire with numerous circumvolutions, galvanometers became so delicate that the electro-chemical equivalent of the smaller currents they indicated was imperceptible for all chemical methods. With the newest galvanometers you can very well observe currents which would want to last a century before decomposing one milligram of water, the smallest quantity which is usually weighed on chemical balances. You see that if such a current lasts only some seconds or some minutes, there is not the slightest hope to discover its products of decomposition by chemical analysis. And even if it should last a long time the feeble quantities of hydrogen collected at the negative electrode can vanish, because they combine with the traces of atmospheric oxygen absorbed by the liquid. Under such conditions a feeble current may continue as long as you like without producing any visible trace of electrolysis, even not of galvanic polarisation, the appearance of which can be used as an indication of previous electrolysis. Galvanic polarisation, as you know, is an altered state of the metallic plates which have been used as electrodes during the decomposition of an electrolyte. Polarised electrodes, when connected by a galvanometer, give a current which they did not give before being polarised. By this current the plates are discharged again and returned to their original state of equality.

This depolarising current is indeed a most delicate means of discovering previous decomposition. I have really ascertained that under favourable conditions one can observe the polarisation produced during some seconds by a current which decomposes one milligram of water in a century.

Products of decomposition cannot appear at the electrodes without motions of the constituent molecules of the electrolyte throughout the whole length of the liquid. This subject has been studied very carefully and for a great number of liquids, by Prof. Hittorff, of Münster, and Prof. G. Wiedemann, of Leipsic.

Prof. F. Kohlrausch, of Würzburg, has brought to light the very important fact that in diluted solutions of salts, including hydrates of acids and hydrates of caustic alkalies, every atom under the influence of currents of the same density moves on with its own peculiar velocity, independently of other atoms moving at the same time in the same or in opposite directions. The total amount of chemical motion in every section of the fluid is represented by the sum of the equivalents of the cation gone forwards and of the anion gone backwards, in the same way as in the dualistic theory of electricity, and the total amount of electricity flowing through a section of the conductor corresponds to the sum of positive electricity going forwards and negative electricity going backwards.

This established, Faraday's law tells us that through each section of an electrolytic conductor we have always equivalent electrical and chemical motion. The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion, and accompanies it during all its motions through the interior of the electrolytic fluid. This we may call the electric charge of the atom.

Now the most startling result, perhaps, of Faraday's law is this: If we accept the hypothesis that the elementary substances are composed of atoms we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity. As long as it moves about on the electrolytic liquid each atom remains united with its electric equivalent or equivalents. At the surface of the electrodes decomposition can take place if there is sufficient electromotive power, and then the atoms give off their electric charges and become electrically neutral.

Now arises the question, Are all these relations between electricity and chemical combination limited to that class of bodies which we know as electrolytes? In order to produce a current of sufficient strength to collect enough of the products of decomposition without producing too much heat in the electrolyte, the substance which we try to decompose ought not to have too much resistance against the current. But this resistance may be very great, and the motion of the ions may be very slow, so slow indeed that we should need to allow it to go on for hundreds of years before we should be able to collect even traces of the products of decomposition; nevertheless all the essential attributes of the process of electrolysis could subsist. If you connect an electrified conductor with one of the electrodes of a cell filled with oil of turpentine, the other with the earth, you will find that the electricity of the conductor is discharged unmistakably more rapidly through the oil of turpentine than if you take it away and fill the cell only with air.

Also in this case we may observe polarisation of the electrodes as a symptom of previous electrolysis. Another sign of electrolytic conduction is that liquids brought between two different metals produce an electromotive force. This is never done by metals of equal temperature, or other conductors which, like metals, let electricity pass without being decomposed.

The same effect is also observed even with a great many rigid bodies, although we have very few solid bodies which allow us to observe this electrolytic conduction with the galvanometer, and even these only at temperatures near to their melting-point. It is nearly impossible to shelter the quadrants of a delicate electrometer against being charged by the insulating bodies by which they are supported.

In all the cases which I have quoted one might suspect that traces of humidity absorbed by the substance or adhering to their surface were the electrolytes. I show you

therefore this little Daniell's cell, in which the porous septum has been substituted by a thin stratum of glass. Externally all is symmetrical at both poles; there is nothing in contact with the air but a closed surface of glass, through which two wires of platinum penetrate. The whole charges the electrometer exactly like a Daniell's cell of very great resistance, and this it would not do if the septum of glass did not behave like an electrolyte. All these facts show that electrolytic conduction is not at all limited to solutions of acids or salts.

Hitherto we have studied the motions of ponderable matter as well as of electricity, going on in an electrolyte. Let us study now the forces which are able to produce these motions. It has always appeared somewhat startling to everybody who knows the mighty power of chemical forces, the enormous quantity of heat and of mechanical work which they are able to produce, and who compares with it the exceedingly small electric attraction which the poles of a battery of two Daniell's cells show. Nevertheless this little apparatus is able to decompose water.

The quantity of electricity which can be conveyed by a very small quantity of hydrogen, when measured by its electrostatic forces, is exceedingly great. Faraday saw this, and has endeavoured in various ways to give at least an approximate determination. The most powerful batteries of Leyden jars, discharged through a voltameter, give scarcely any visible traces of gases. At present we can give definite numbers. The result is that the electricity of 1 m.grm. of water, separated and communicated to two balls, 1 kilometre distant, would produce an attraction between them, equal to the weight of 25 000 kilos.

The total force exerted by the attraction of an electrified body upon another charged with opposite electricity is always proportional to the quantity of electricity contained in the attracting as on the attracted body, and therefore even the feeble electric tension of two Daniell's elements, acting through an electrolytic cell upon the enormous quantities of electricity with which the constituent ions of water are charged, is mighty enough to separate these elements and to keep them separated.

We now turn to investigate what motions of the ponderable molecules require the action of these forces. Let us begin with the case where the conducting liquid is surrounded everywhere by insulating bodies. Then no electricity can enter, none can go out through its surface, but positive electricity can be driven to one side, negative to the other, by the attracting and repelling forces of external electrified bodies. This process going on as well in every metallic conductor is called "electrostatic induction." Liquid conductors behave quite like metals under these conditions. Prof. Wüllner has proved that even our best insulators, exposed to electric forces for a long time, are charged at last quite in the same way as metals would be charged in an instant. There can be no doubt that even electromotive forces going down to less than $\frac{1}{10}$ Daniell produce perfect electrical equilibrium in the interior of an electrolytic liquid.

Another somewhat modified instance of the same effects is afforded by a voltametric cell containing two electrodes of platinum, which are connected with a Daniell's cell, the electromotive force of which is insufficient to decompose the electrolyte. Under this condition the ions carried to the electrodes cannot give off their electric charges. The whole apparatus behaves, as was first accentuated by Sir W. Thomson, like a condenser of enormous capacity.

Observing the polarising and depolarising currents in a cell containing two electrodes of platinum, hermetically sealed and freed of all air, we can observe these phenomena with the most feeble electromotive forces of $\frac{1}{10000}$ Daniell, and I found that down to this limit the capacity of the platinum surfaces proved to be constant. By taking greater surfaces of platinum I suppose it will be possible to reach a limit much lower than that. If any chemical force existed besides that of the electrical charges which could bind all the pairs of opposite ions together, and require any amount of work to be vanquished, an inferior limit to the electromotive forces ought to exist, which forces are able to attract the atoms to the electrodes and to charge these as condensers. No phenomenon indicating such a limit has as yet been discovered, and we must conclude therefore that no other force resists the motions of the ions through the interior of the liquid than the mutual attractions of their electric charges.

On the contrary, as soon as an ion is to be separated from its electrical charge we find that the electrical forces of the battery meet with a powerful resistance, the overpowering of which requires a good deal of work to be done. Usually the ions, losing their electric charges, are separated at the same time from the liquid; some of them are evolved as gases, others are deposited as rigid strata on the surface of the electrodes, like galvanoplastic copper. But the union of two constituents having powerful affinity to form a chemical compound, as you know very well, produces always a great amount of heat, and heat is equivalent to work. On the contrary, decomposition of the compound substances requires work, because it restores the energy of the chemical forces, which has been spent by the act of combination.

Metals uniting with oxygen or halogens produce heat in the same way, some of them, like potassium, sodium, zinc, even more heat than an equivalent quantity of hydrogen; less oxidisible metals, like copper, silver, platinum, less. We find therefore that heat is generated when zinc drives copper out of its combination with the compound halogen of sulphuric acid, as is the case in a Daniell's cell.

If a galvanic current passes through any conductor, a metallic wire, or an electrolytic fluid, it evolves heat. Mr. Prescott Joule was the first who proved experimentally that if no other work is done by the current the total amount of heat evolved in a galvanic circuit during a certain time is exactly equal to that which ought to have been generated by the chemical actions which have been performed during that time. But this heat is not evolved at the surface of the electrodes, where these chemical actions take place, but is evolved in all the parts of the circuit, proportionally to the galvanic resistance of every part. From this it is evident that the heat evolved is an immediate effect, not of the chemical action, but of the galvanic current, and that the chemical work of the battery has been spent in producing only the electric action.

If we apply Faraday's law, a definite amount of electricity passing through the circuit corresponds to a definite amount of chemical decomposition going on in every electrolytic cell of the same circuit. According to the theory of electricity the work done by such a definite quantity of electricity which passes, producing a current, is proportionate to the electromotive force acting between both ends of the conductor. You, see therefore, that the electromotive force of a galvanic circuit must be, and is indeed, proportionate to the heat generated by the sum of all the chemical actions going on in all the electrolytic cells during the passage of the same quantity of electricity. In cells of the galvanic battery chemical forces are brought into action able to produce work; in cells in which decomposition is occurring work must be done against opposing chemical forces; the rest of the work done appears as heat evolved by the current, as far as it is not used up to produce motions of magnets or other equivalents of work.

Hitherto we have supposed that the ion with its electric charge is separated from the fluid. But the ponderable atoms can give off their electricity to the electrode, and remain in the liquid, being now electrically neutral. This makes almost no difference in the value of the electromotive force. For instance, if chlorine is separated at the anode, it will remain at first absorbed by the liquid; if the solution becomes saturated, or if we make a vacuum

over the liquid, the gas will rise in bubbles. The electromotive force remains unaltered. The same may be observed with all the other gases. You see in this case that the change of electrically negative chlorine into neutral chlorine is the process which requires so great an amount of work, even if the ponderable matter of the atoms remains where it was.

The more the surface of the positive electrode is covered with negative atoms of the anion, and the negative with the positive ones of the cation, the more the attracting force of the electrodes exerted upon the ions of the liquid is diminished by this second stratum of opposite electricity covering them. On the contrary, the force with which the positive electricity of an atom of hydrogen is attracted towards the negatively charged metal increases in proportion as more negative electricity collects before it on the metal, and the more negative electricity collects behind it in the fluid.

Such is the mechanism by which electric force is concentrated and increased in its intensity to such a degree that it becomes able to overpower the mightiest chemical affinities we know of. If this can be done by a polarised surface, acting like a condenser, charged by a very moderate electromotive force, can the attractions between the enormous electric charges of anions and cations play an unimportant and indifferent part in chemical affinity?

You see, therefore, if we use the language of the dualistic theory and treat positive and negative electricities as two substances, the phenomena are the same as if equivalents of positive and negative electricity were attracted by different atoms, and perhaps also by the different values of affinity belonging to the same atom with different force. Potassium, sodium, zinc, must have strong attraction to a positive charge; oxygen, chlorine, bromine to a negative charge.

Faraday very often recurs to this to express his conviction that the forces termed chemical affinity and electricity are one and the same. I have endeavoured to give you a survey of the facts in their mutual connection, avoiding, as far as possible, introducing other hypotheses, except the atomic theory of modern chemistry. I think the facts leave no doubt that the very mightiest among the chemical forces are of electric origin. The atoms cling to their electric charges and the opposite electric charges cling to the atoms. But I don't suppose that other molecular forces are excluded, working directly from atom to atom. Several of our leading chemists have begun lately to distinguish two classes of compounds, molecular aggregates and typical compounds. The latter are united by atomic affinities, the former not. Electrolytes belong to the latter class.

If we conclude from the facts that every unit of affinity of every atom is charged always with one equivalent either of positive or of negative electricity, they can form compounds, being electrically neutral, only if every unit charged positively unites under the influence of a mighty electric attraction with another unit charged negatively. You see that this ought to produce compounds in which every unit of affinity of every atom is connected with one and only with one other unit of another atom. This is, as you will see immediately, indeed, the modern chemical theory of quantivalence, comprising all the saturated compounds. The fact that even elementary substances, with few exceptions, have molecules composed of two atoms, makes it probable that even in these cases electric neutralisation is produced by the combination of two atoms, each charged with its electric equivalent, not by neutralisation of every single unit of affinity.

But I abstain from entering into mere specialities, as, for instance, the question of unsaturated compounds; perhaps I have gone already too far. I would not have dared to do it if I did not feel myself sheltered by the authority of that great man who was guided by a never-erring instinct of truth. I thought that the best I could do for his memory was to recall to the minds of the men, by the energy and intelligence of whom chemistry has undergone its modern astonishing development, what important treasures of knowledge lie still hidden in the works of that wonderful genius. I am not sufficiently acquainted with chemistry to be confident that I have given the right interpretation, that interpretation which Faraday himself would have given perhaps, if he had known the law of chemical quantivalence, if he had had the experimental means of ascertaining how large the extent, how unexceptional the accuracy of his law really is: and if he had known the precise formulation of the law of energy applied to chemical work, and of the laws which determine the distribution of electric forces in space as well as in ponderable bodies transmitting electric current or forming condensers. I shall consider my work of to-day well rewarded if I have succeeded in kindling anew the interest of chemists for the electro-chemical part of their science.

FURTHER CONTRIBUTIONS TO THE CHEMISTRY OF BAST FIBRES.*

By E. J. BEVAN and C. F. CROSS.

In our first paper on this subject (April, 1880) we were able to report some considerable progress towards a solution, in general terms, of the problems presented in this field of natural chemistry: our subsequent researches have led us to certain more precise conclusions, while confirming the general view which we advanced, especially in reference to the aromatic constituents of these fibres; and we think they are of sufficient importance and certainty to justify this brief anticipation of their publication in detail. Witholding, then, for the present their formal development, we may state their main result, which is to identify the aromatic bodies in question with the *tannins*. The formula which we worked out for the product of chlorination of the jute fibre (*i.e.*, its aromatic constituent) was, it will be remembered, $C_{19}H_{18}Cl_4O_9$. This body bears a certain resemblance to chloranil, sufficiently close as, with its more complicated structure and amorphous nature, to warrant our regarding it as a quinone derivative. We were further struck with the analogy of the formula with certain others representing products of plant growth, *e.g.*, aloin, $C_{17}H_{18}O_7$, luteolin, $C_{20}H_{14}O_8$; this is especially the case with catechin, $C_{19}H_{18}O_8$, as we afterwards discovered. Now, in passing to a comparative investigation of this body we found that both it and the tannic acid, with which it is associated in catechin, yielded on treatment with potassium chlorate and hydrochloric acid, the same tetrachlorinated derivative, $C_{20}H_{19}Cl_4O_{12}$, a body not only similar in composition to that formulated above, but having the same characteristics. We next found that catechu, and pure tannin itself, gave on treatment with chlorine, followed by Na_2SO_3, the brilliant magenta colouration which we described as characteristic of bast fibres under the same treatment. Having, moreover, a specimen of decayed jute at hand we investigated it in the light of these results, and succeeded in isolating a quantity of a tannin, evidently a product of the degradation of the fibre; the normal jute (from the same bale) containing traces only of matters soluble in water. Further, the "resinous" substance obtained as a precipitate from the alkaline extract of the esparto fibre, on neutralising, was converted, by heating under pressure with Na_2SO_3 (solution), into a soluble modification, which was identified as a tannin. This conclusion, that the characteristic constituent of bast fibres is a (potential) tannin, not only harmonises all our theoretical results, but throws great light on the technology of the subject. The affinities of jute, which we may take as typical, for colouring-matters are precisely those of tannin-mordanted cotton. The destruction of the jute fibre under the action of superheated steam, and its prevention, which has been made the sub-

* Read before the Owens College Chemical Society, April 2, 1881.

ject of a recent patent by one of us, are exactly parallel with the behaviour of tannin under the same conditions. Certain points in connection with this part of the subject are still under investigation, as is also the chemistry of the carbohydrate with which this bast tannin is associated. These, together with the more important physiological problems, we hope also in some measure to elucidate before publishing our researches *in extenso*.

A NEW ALKALIMETRIC INDICATOR.

By H. W. LANGBECK.

Nitro-phenic acid dissolved in 100,000 parts of distilled water presents a nearly colourless liquid, but if a trace only of an alkali be added a distinct yellow colour appears. This delicate indicator is, of course, only useful if colourless or slightly coloured fluids are to be examined. In determining, for instance, the temporary hardness of water, I dissolve 1 part of nitro-phenic acid in 5000 parts of distilled water, I also prepare centinormal potash and acetic acid solutions. 100 c.c. of distilled water are put into one Nessler glass, the same quantity into another, and again 100 c.c. of the water to be examined into a third. To each of them 5 c.c. of nitro-phenic acid solution are added (one is kept for comparing), which leaves the distilled water nearly colourless, while the common water turns yellow to deep yellow according to hardness. From a burette centinormal potash solution is then added to the one glass of distilled water until the colour is of the same shade as the common water: each c.c. used is equal to 0·00028 of lime, CaO. To verify the result, centinormal acetic acid is added until the first shade (nearly colourless) returns: the quantity of acid required is, of course, the same as the alkali. The common water is now also treated with the centinormal acid until the first shade is reached: each c.c. used equals 0·0005 of carbonate of lime.

I compared, for instance, 100 c c. of distilled water with 100 c c. of water of the East London Company. The distilled water required 1·9 centinormal potash solution to colour it the same shade as the common water, and also 1·9 c.c. of acid to become nearly colourless again: the water in question contained, therefore, 0·532 lime (CaO) in 100,000 parts. The common water required 29·8 c.c. to return to the first shade. From this quantity 1·9 = lime found must be deducted. Each of the remaining c.c. is equal to 0·0005 carbonate of lime, = 13·95 in 100,000 parts, or total temporary hardness = 14·482.

ON THE ESTIMATION OF PEROXIDE OF HYDROGEN.

(Reply to Dr. Em. Schöne.)

By C. T. KINGZETT, F.C.S., F.I.C.

As an advocate of the exercise of criticism in scientific work, I cannot shrink from it when directed against my own investigations. I therefore address myself to the task of answering Dr. Schöne's remarks (Chemical News, vol. xliii., p. 149), so that the readers of these columns may judge between my critic and me.

Dr. Schöne is correct in stating that I recommend the use of a great excess of dilute sulphuric acid in the quantitative determination of hydric peroxide by the iodometric method, but he is incorrect in expressing that great excess as consisting of from one to five volumes of 1 : 3 acid.

In my paper* (p. 803), for the purpose of illustrating certain newly-ascertained facts, I used various quantities, but, as evidenced by the results, it was shown that full decomposition of the peroxide was obtained in a few minutes in those cases where half a volume of the dilute acid was used. I repeat here, what I also then stated, viz., that I have made hundreds of determinations —I might say thousands without exaggeration,— by this modified process, with ease and accuracy.*

However, Dr. Schöne says the process is inaccurate, because Bunsen has shown certain results to accrue from the admixture of aqueous solutions of hydriodic and sulphuric acids of given strength (and under certain conditions), and because of the action of oxygen upon hydriodic acid. He also says I "should have at least determined precisely the peroxide of hydrogen in the trial solutions by a more trustworthy method."

As regards the first two objections I shall now show, by the description of further experiments, that they are of no validity; and as regards the third objection I beg to make reference to p. 807 (my paper), where the concordant results of determining the peroxide by three distinct methods are given. But even as regards this point I now adduce further evidence.

A solution of peroxide of hydrogen was prepared, and titrated with permanganate of potassium in the ordinary way:—

(A.) 20 c.c. H_2O_2 solution required 4·2 c.c. $KMnO_4$.
(B.) 20 c.c. H_2O_2 " " 4·2 c.c. "
of which 10 c.c. = 8·1 c.c. $Na_2S_2O_3$ N/10 solution.

Of this same solution of peroxide 5 portions of 20 c.c. each were placed in as many flasks, and acidified with, respectively, 5, 10, 20, 40, and 60 c.c. dilute (1 : 3) sulphuric acid. Potassium iodide in crystals was then added to each, and after standing five minutes the iodine was estimated by titration with decinormal thiosulphate in the usual way.

A	required	3·5 c.c.	$Na_2S_2O_3$.
B	"	3·5 "	"
C	"	3·5 "	"
D	"	3·6 "	"
E	"	3·6 "	"

In A and B the indications at the end of the titrations were as sharp as could be wished, but in C, D, and E they were not so sharp—an effect which is perhaps connected with some action of the large amounts of acid present upon the starch.

Now 3·5 c.c. $Na_2S_2O_3$ = 4·3 c.c. $KMnO_4$, against 4·2 c.c. $KMnO_4$ as required by titration with that reagent of the strength in question.

It should be clearly understood that I do not by any means recommend the use of such large quantities of acid as were employed in C, D, and E. Here they were used to support my statement that the objections urged by Dr. Schöne will not bear investigation, and this I submit they clearly show. At the same time, the results obtained indicate as close an agreement between the two methods employed as can be wished for in laboratory practice.

In another experiment, a mixture of 20 c.c. of the peroxide, with 5 c.c. of the acid and excess of KI, was allowed to stand exposed to the air for forty minutes, after which, on titration, the iodine set free required 3·5 c.c. N/10 hyposulphite, proving (if my former paper lacked proof) that the whole of the peroxide is decomposed within the first five minutes, working under the observed conditions, and that the oxygen of the air exercised no disturbing influence.

Again, a fresh solution of peroxide of hydrogen was prepared, of which 5 c.c. required 10·4 c.c. of the standard solution of permanganate.

(A.) 5 c.c., with 5 c.c. of 1 : 3 H_2SO_4 and KI crystals, set free iodine in five minutes = 8·2 c.c. N/10 $Na_2S_2O_3$.
(B.) 5 c.c. in this control experiment liberated iodine in five minutes = 8·2 c.c. N/10 $Na_2S_2O_3$.

In both cases the decomposition was complete.

* *Journ. Chem. Soc.*, 1880 (pp. 792—807).

* It should have been stated in my original paper that, when solutions of the peroxide are above 2-volume strength, I always dilute them before conducting the process.—C. T. K.

Now 8·2 c.c. $Na_2S_2O_3$ = 10·12 c.c. $KMnO_4$. Thus, the two methods again show as good an agreement in results as can be wished for.

Further, these results, together with those I have previously published, prove that, working with ordinary solutions of hydric peroxide, accurate determinations can be most easily effected with the iodometric method modified as set forth, viz., by the use of a reasonably large excess of dilute sulphuric acid,—avoiding such a ridiculously great excess as was employed by Dr. Schöne in two experiments, in which he also used an extremely attenuated solution of hydric peroxide.

The hydric peroxide concerned in most of my experiments* has been obtained either by the atmospheric oxidation of turpentine over water (in which case the permanganate method is out of the question), or of phosphorus, and its quantity has never been so small as to necessitate the development of the process I have used, so that it may apply to such infinitesimal quantities of H_2O_2 as have been observed by Dr. Schöne to be present in certain aqueous precipitates. Interesting as are his results in this direction, they have a special purport, and do not by their requirements in any way detract from the exactitude of my own observations.

Dr. Schöne also draws attention to the fact that, while my experiments confirm the observations recorded by him as to the action of pure neutral hydric peroxide upon potassic iodide, I have yet worded my conclusion respecting it somewhat inconsistently. He is quite right. Having regard to the very small amount of iodine liberated, I thought it might be passed over in summing up. But perhaps I ought not to have passed over it, although my experiments—which are described in detail, and reveal the truth—stand as a record of my meaning.

I now come to the last point at issue with Dr. Schöne, and that concerns his so-called colorimetric method for the estimation of peroxide of hydrogen in atmospheric deposits.

Neutral peroxide of hydrogen decomposes neutral potassic iodide, liberating oxygen gas, while the solution becomes alkaline, and a little iodine is liberated. For instance, to-day I took 100 c.c. of an aqueous solution of H_2O_2 capable of liberating iodine from an acid solution of KI equal to 164 c.c. N/10 $Na_2S_2O_3$. It was neutralised exactly with pure caustic soda, and then some crystals of KI were added, and the mixture was stirred. Oxygen was liberated in abundance, and the solution became alkaline, while iodine was set free. After half an hour the iodine required 3·6 c.c. of the standard thiosulphate. Now this iodine is set free by one of four reactions, supposed by Dr. Schöne to represent the whole truth. They are respectively represented by—

(A.) $2KI + 2H_2O = 2KHO + 2HI.$
(B.) $H_2O_2 + 2KHO = K_2O_2 + 2H_2O.$
(C.) $2HI + H_2O_2 = I_2 + 2H_2O.$
(D.) $K_2O_2 + I_2 = 2KI + O_2.$

In my Report to the Chemical Society I wrote in a footnote "I cannot understand how he (Dr. Schöne) can advocate the use of this system of changes for determining atmospheric H_2O_2." I could not understand it because I was not clear that the amount of iodine liberated was a constant quantity, for it seems to be upon this supposition that Dr. Schöne bases his colorimetric method. I cannot understand it now because my doubts are, if anything, intensified by Dr. Schöne's admitted knowledge of the fact that—as he points out in his criticism of my work—"iodide of hydrogen is decomposed by free oxygen, always to be found in the solutions of peroxide" (and, he might have added, even more abundant in common air). Do not these sources of error militate against the accuracy of his method, which may almost be said to be based upon the fact that oxygen decomposes hydriodic acid? and, if so, may not that error be most serious if the solution of peroxide of hydrogen requiring examination only contains from 0·08 to 1 m.grm. per litre? I fail to see how he can urge this action of oxygen upon hydriodic acid as an objection to the process used by me, remembering that the reaction is $2KI + H_2SO_4 + H_2O_2 = K_2SO_4 + 2H_2O + I_2$.

I might add that, brief as is the abstract of Dr. Schöne's paper (*Annalen*, 195, p. 228), given on page 353 of the *Journal of the Chemical Society* for 1880 (Abstracts), there is a good and clear account of his colorimetric method given on page 743 of the same volume.

In conclusion, without desiring to prejudge the questions still at issue between Dr. Schöne and myself, I submit that this communication is a complete answer to the various objections he has urged against my Report on the Atmospheric Oxidation of Phosphorus.

* In the experiments herein recited peroxide of hydrogen obtained in the ordinary way has been, of course, employed.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 30th, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The President gave his annual address on the general condition of the Society. At no period in its history has the Society been in such a flourishing condition. The number of Fellows (1096) is the largest ever recorded. The papers read have increased both in number and importance, whilst the attendance and interest displayed at the meetings have at all events not diminished. The income has also increased, being £2916 as against £2719, the income of the preceding year. The number of papers read (113) has precluded the necessity of having lectures during the past season. The *Journal* still upholds its character for accuracy and usefulness. Many additions have been made to the Library; duplicate sets of some periodicals have been purchased. The books have been re-arranged, and are now classified according to subjects. Two card catalogues have been prepared; one arranged according to the authors' names, the other according to subjects.

The Research Fund, founded in 1876 by the donation of £1000 from Dr. Longstaff, now amounts to £4427. The City Companies have materially aided the foundation of this fund. Up to the present time thirty-seven grants have been made in sums varying from £100 to £5, and amounting in all to £1021.

The President then briefly alluded to the more important discoveries in chemical science during the past year. The observed alteration in the density of chlorine has been admitted by Victor Meyer to be due to some unexplained error; whilst the well-established fact of the diminution in density of the vapour of iodine at a white-heat can be explained by the dissociation of the molecules of that element. The solar and stellar evidence of the question of the decomposition of metals is being accumulated by Mr. Lockyer, but as yet has not assumed a sufficiently cogent form to enforce its general acceptance by chemists,—perhaps because the nature of the proof is not one with which they are familiar. The researches of Capt. Abney in conjunction with Col. Festing have been continued with conspicuous success. By photographing the absorption spectra of organic compounds in the infra red part of the spectrum they have accomplished for organic metals what ordinary high temperature spectrum analysis does for the inorganic metals. In these invisible portions of the spectrum are characteristic bands and lines for each organic radical, so that at a glance these photographs decide whether or not ethyl, methyl, &c., are present, just as a glance at the luminous portion of the spectrum satisfies us as to the presence of calcium, sodium, &c.: an investigation of greater importance to chemistry has seldom, if ever, been communicated to the

Society. An equally important confirmation of certain fundamental views of modern chemistry has been obtained by Helmholtz from a discussion of electro-phenomena: an account of these will be given at the forthcoming Faraday lecture. During the past twelve months not only has Baeyer succeeded in producing indigo artificially, but its manufacture on a commercial scale has been undertaken by competent hands. The first point of departure was cinnamic acid; the last link in the chain ortho-nitrophenyl-propiolic acid, from an alkaline solution of which pure indigo-blue separates out on heating with grape-sugar. The theoretical yield of indigo is 68 per cent; 40 per cent has been obtained. Kolbe's idea, that the four combining units of each carbon atom are not of equal volume, was apparently verified by Schreiner's researches on the methyl-ethyl carbonic ethers. Geuther and Roese have, however, obtained results which flatly contradict those of Schreiner. Various new and rare metals have been prepared by Marignac, Nilson, Clève, &c.

The Society has lost by death two foreign members—Prof. Heintz, of Halle, and Prof. Mulder, of Amsterdam; and ten Fellows—Sir B. C. Brodie, Dr. Stenhouse, Prof. W. Hallows Miller, Messrs. J. Tennant, W. W. Stoddart, W. Arnot, A. C. Bruce, T. Eltoft, R. Johnson, and the Rev. D. W. Ladley.

The President then presented the Longstaff Medal to Prof. Thorpe, of the Yorkshire College, as the Fellow who, in the opinion of the Council, had done the most to promote chemical science by research during the past three years. The medal is of bronze; on one side is a very successful portrait of Dr. Longstaff. The medallion portrait is by Mr. A. Bruce Joy, the dies by Wyon, and the medal was struck at the Mint: it is accompanied by a purse of £20.

Dr. Longstaff rose to propose a vote of thanks to the President for his report, and to move its adoption. He said that it was a source of great gratification to him to be present at the presentation of the first Longstaff medal. He traced back his love of Science to the perusal of three books when a schoolboy—Joyce's "Scientific Dialogues," Blair's "Primer of Chemistry," and "The Life of Dr. Franklin." His researches had been principally confined to the application of chemistry to manufacturing purposes, but he hoped by his share in promoting the Research Fund that he had contributed something toward the advancement of scientific research. He trusted that the Research Fund would be still more successful, and that more persons who had benefitted by the application of discoveries in chemistry to manufactures would come forward and contribute.

Mr. Carteighe, in seconding Dr. Longstaff, referred to the debt which the Society owed to the President for his very regular attendance.

The President, in returning thanks, said that no apology was needed from Dr. Longstaff. He had originated the Research Fund, and had thus done a very good work for the progress of Science.

The Treasurer, Dr. Russell, then read his Report. The principal items are as follow:—Receipts by subscriptions, £2287; sale of *Journal* and Index, £323; dividends, £223. Expenses: *Journal*, £1688; library, £441; house expenses, £176; collector's commission, £114. The total income is about £2900; the expenditure £2600. The assets amount to £8193.

The Treasurer congratulated the Society on its very very flourishing financial condition, and pointed out specially the increase in the subscriptions and in the sale of the *Journal*.

The Treasurer then gave an account of the Research Fund, the principal items of which are given in the President's Address.

The Auditors then presented their Report, and various votes of thanks were passed. The Society then ballotted for the Officers and Council for the ensuing year. The Scrutators, Dr. Japp and Mr. J. Spiller, declared the following to have been duly elected:—

President—H. E. Roscoe.

Vice-Presidents—F. A. Abel, Warren De La Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, A. Crum Brown, J. Dewar, J. H. Gilbert, A. V. Harcourt, J. E. Reynolds, J. Young.

Secretaries—W. H. Perkin, H. E. Armstrong.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Council—F. D. Brown, M. Carteighe, H. McLeod, G. H. Makins, E. J. Mills, W. C. Roberts, C. Schorlemmer, J. M. Thomson, C. M. Tidy, W. Thorp, T. E. Thorpe, R. Warington.

PHYSICAL SOCIETY.

Saturday, March 26, 1881.

Prof. Fuller in the Chair.

New Member. Mr. Lewis Wright, author and editor.

Dr. James Moser read a paper on "*Electrostatic Induction, especially relating to the Branching of the Induction in the Differential Inductometer and in the Electrophorus.*" The author's experiments bore out the hypothesis of induction as enunciated by Faraday.

Prof. Ayrton suggested the importance of adding guard-rings to the small plates of the five-plate inductometer or balance, since without these mathematical calculations could not be accurately applied, and the experimental determination of specific inductive capacity would be doubtful.

Dr. Moser pointed out that though the theory was not absolutely correct, it lay with the experimenter to get results very approximately correct.

Prof. Reinold, one of the Secretaries of the Society, read a paper, by himself and Prof. Rücker, "*On the Electrical Resistance of Liquid Films with a Revision of Newton's Scale of Colours.*" The experiments were in continuation of those published by the authors in 1877. Their object was to determine whether a film thinning under the action of gravity gave any evidence, by change in its specific resistance, of an approach to a thickness equal to twice the radius of the molecular attraction, and also to devise a method of finding the amount of water which might be absorbed by or evaporated from it. The thickness of the films was determined from their colour by means of two beams reflected from different mirrors on them. Newton's scale of colours was revised by observations on Newton's rings, and partly by more than two thousand observations on the rings themselves. The thicknesses determined by direct observations on Newton's rings and those in the corrected table rarely differ by 1 per cent, while Newton's scale in parts differs from both by as much as 10 per cent of the thickness. The films were formed from a solution of oleate of soda in glycerin, with a little nitrate of potash added to increase their electric conductivity. They were blown in a glass case from which the outer air could be excluded. Precautions were taken to keep the air in contact with the films inside the case at a proper humidity. These consisted in placing disks containing the solution at the bottom of the case, and suspending within it sheets of blotting-paper, the lower edges of which were dipped into the liquid. A hair hygrometer indicated changes in the humidity of the interior. The resistance of the films was measured by piercing them with gold wires, which were connected with the electrodes of a quadrant electrometer. The resistance of the film between the needles was calculated by comparing the deflection caused by the difference of potential of the two wires when a current was passing through the film with that produced by the difference of potential above and below a known resistance placed in the same circuit. The specific resistance of the liquid from which the films were formed was measured by a method identical in principle

with the above. The liquid was contained in a glass tube with turned-up ends. Platinum wires were cemented into small holes drilled in the straight part of the tube, and their difference of potential compared with that of two points in the same circuit separated by a known resistance. This method has the great advantage of getting rid of any difficulties connected with polarisation. Test experiments on sulphuric acid proved the method to give results agreeing with those of Kohlrausch, who employed alternating currents and Wheatstone's bridge. The results of the experiments may be summed up as follows:—It is difficult to form a soap film under conditions precluding a slight evaporation or absorption of water, but the more nearly these conditions are attained the more closely does the specific resistance of the film agree with that of the liquid in mass. The films observed under the most favourable conditions obeyed Ohm's law with great accuracy, and much better than the others. The films indicate no approach to a thickness equal to the diameter of molecular attraction. A soap film may even in an enclosed space readily loose 23 out of 57·7 volumes of water contained in every 100 volumes of the solution, when special precautions are not taken to maintain the surrounding space in a constant hygrometric condition.

Prof. Ayrton suggested that in measuring the liquids and film the distance between the electrodes should be varied.

Prof. Guthrie pointed out that the results of Prof. Reinold and Kohlrausch agreed with his own in showing that the conductivity of liquids obeyed Ohm's law.

THE SOCIETY OF CHEMICAL INDUSTRY.

On Monday afternoon, 4th inst., the meeting referred to in our last issue was held in the Lecture Room of the Chemical Society, Burlington House. There was a very considerable attendance which included many Practical Chemists and Chemical Engineers of note, among whom were Professors Abel and Armstrong; Drs. Hewitt, Longstaff, and Russell; Messrs. Lowthian Bell, Alexander Chance, Carey Howard, Hermann, Gossage, Kingzett, Ludwig Mond, J. Spiller, and many others.

Professor Roscoe took the chair, and after some explanatory remarks as to the probable great utility of a Society such as was proposed, moved a resolution to the effect—"That the Society of Chemical Industry be then and hereby established."

This was duly seconded after some remarks from Dr. Longstaff and Mr. Kingzett. The latter feared the probability of collision between the Institute of Chemistry and the proposed Society of Chemical Industry.

Professor Abel, the President of the Institute, took occasion to emphatically state his conviction that there would be no clashing of interests, nor any doubt that there was plenty of room for the work of such a Society.

Some discussion arose as to whether the name of the Society should be the "Society of Chemical Industry," or the "Society of Chemical Engineers." The latter name was very largely supported on the ground that most of the difficulties in the application of chemical science arose on the question of apparatus and physical condition involved. After considerable discussion it was resolved to call the Society "The Society of Chemical Industry."

The following gentlemen were elected the first council:—*President*—Professor Roscoe, F.R.S.; *Vice Presidents*—Prof. Abel, F.R.S., Prof. A. W. Williamson, F.R.S., Messrs. I. Lowthian Bell, F.R.S., W. H. Perkin, F.R.S., Drs. C. W. Siemens, F.R.S., Angus Smith, F.R.S., Messrs. Jas. Young, F.R.S., F. H. Gossage, E. K. Muspratt, H. Lee Pattinson, W. Weldon, and Dr. Longstaff; *Committee*—Capt. Abney, F.R.S., Prof. Chas. Graham, Messrs. W. Crookes, F.R.S., P. Greiss, F.R.S., Dr. Hewitt, D. Howard, Jas. Mactear, H. Sprengel, H. Tate, P. Worsley, J. Spiller, and A. Chance; *Treasurer*—Mr. E. Rider Cook; *Secretaries*—Hon. Sec., Mr. G. E. Davis; Local and District Secs., Messrs. Eustace Carey, Ludwig Mond, and Thomas Tyrer.

The subscription was, after a vote, made for the first year one guinea.

The gentlemen present were made members of the Society without entrance fee, and a period of six months will be allowed during which any gentlemen considered eligible by the Council will be admitted as members.

Forms of application will be supplied by general and local Secretaries.

The address of Mr. Thomas Tyrer, the Secretary of the London District, is Garden Wharf, Battersea.

The usual vote of thanks to the Chairman concluded the business of the meeting.

Particulars as to the meetings, head quarters, &c., of the Society, will be published in due course.

CORRESPONDENCE.

BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—As the writer of the letter from which has sprung the correspondence now appearing in your journal, and referring to benzol testing, may I ask your permission for the insertion of a second epistle touching the same subject. That it is not without interest may be inferred from the nature and extent of the transactions connected with it, and as stated by one of the writers in your last impression.

So far as one can gather from the various correspondents who have ventured their opinions, discrepancies in the operation of testing only occasionally occur; my own experience proves such as of daily and constant occurrence. I do not, however, think the question has been dealt with in the manner that might have been anticipated from some of the writers who appear to be analysts, and, as such, accustomed to seek out cause and effect altogether outside the "commercial element."

So far as my observation is concerned there are causes that tend to influence the results obtained under the time-honoured test by boiling-points, quite irrespective of the "commercial side," although unfortunately they may be made directly subservient to its bias and wishes. I refer to the possibility of obtaining varied results in the operation when conducted purely as a question of science, and with the most accurately adjusted instruments.

The method of examining and reporting by boiling-points has been pretty freely detailed in the recent correspondence, but some of the more important facts connected with it have been entirely omitted, intentionally or otherwise I am unable to say.

My original question had direct reference to the matter of thermometers employed in registering the operation, and as conducted in accordance with the well-understood contract terms. As it is one that plays an important part in the system, it may not be uninteresting to afford some idea of the wide discrepancies that can occur in the absence of care in selecting appropriate instruments. So long as we are dealing with fluids of constant or nearly constant boiling-points, thermometers of different forms and dimensions will, if accurately constructed, register alike; but in the case of complex liquids, such as commercial benzol, containing hydrocarbons of very unequal boiling-points and densities, the case becomes altogether different. Such a fluid contains true benzol, boiling at 81° to 82° C. with a sp. gr. of 0·885. Toluol, boiling at 111° C., sp. gr. 0·871. Xylol, boiling at 136° to 138° C., sp. gr. 0·868; and in many cases even higher homologues, associated with bodies of a different character. From one class of tars, compounds are introduced boiling as low as 20° C., with gravities ranging from 0·900 to 1·000, such as the alliol of Mansfield; bisulphide of carbon with other sulphur compounds are also frequently present to the extent of 2 to 4 per cent, whilst from another class, usually north country,

we meet with products allied to the petroleum series boiling low with contra low gravities (under 0·850).

Now, a glance at these facts, and which are tolerably well known to tar distillers, notwithstanding the ignorance with which they are accredited, at once suggests varied conditions in the rate of boiling and distilling. During the interval in which the first 20 to 30 per cent passes over the light boiling compounds that may be present are escaping and condensing with very unequal ratio, and may to those unacquainted with the fact give rise to the most perpiexing anomalies, even the shape and dimensions of the distilling vessel employed materially influences the result. Let any person accustomed to the test, and honestly seeking facts outside the "commercial element" and its interests, provide himself with the prescribed:—6 or 8 ounce retort and condensor, measure into the same his 100 c.c. of the benzol to be tested, say commercial 90 per cent, and having inserted the thermometer at the orthodox distance of ¾ of an inch from the bottom, proceed to distil, carefully observing the usual, although very ambiguous, conditions laid down as regards drops and rate of running. The first fact noticeable will be that "different thermometers," as originally stated, "do not register the same and exact quantity of fluid over at given temperatures." It is at and up to the temperature of 85° C. that the great departure is met with, and during which the light boiling and highly volatile fluids are doing their utmost to escape from the retort. Beyond this degree each and all, if correct, will indicate alike. Instruments with mercury bulbs, differing considerably in size, mercurial columns varying in length, are each, in their way, elements of disturbing cause, and give rise to errors of some magnitude. I have seen a couple of instruments, equal as regards dimensions of bulb and capillary bore, but differing in length of column and by a space of 6 inches in the marking for 100° C., record wide variations. Employing these thermometers respectively on a given sample of 90 per cent benzol, I have witnessed 23 and 33 per cent obtained at pleasure, and for any number of repetitions at the 85° point, the rate of distillation in all cases being rigidly the same. Now, as this happens to be a critical point in forming an estimate on a given sample of such percentage, and may throw discredit on the same, or even condemn it, the fact is not without significance, and is ominously suggestive of the "commercial element" darkly hinted at by one of your correspondents, from my point of view, the possibility of buyers' and sellers' thermometers.

Some exception may be taken to the selection of high quality benzol, although I think one of your writers has stated that "90 per cents are unaffected by the usual disturbing causes." I can only say this is not my experience, and I have further witnessed the more commonly-met with 50 per cent material show 47 only with a delicate short-column instrument, and 52 with a second, differing in the length of its marking by some six inches; after passing the division for 100° C. and onwards to 120°, both instruments indicate alike, showing that in this example, as with the other, the light boiling substances exist as disturbing causes. In the one case the mercury rises before the benzol has really had time to distil, in the other the action is slower, and consequently equalised.

Much has been said regarding the utility and value of the method so long followed in benzol testing, and there are many who think it so simple and perfect that it is incapable of improvement. I, for one, have my own views, and may at a future time ask your kind permission for the insertion of results obtained under a line of work conducted at my own wish and suggestion.

Benzol, toluol, and xylol are now recognised products in active demand, not in admixture only, but as pure substances, and I am at a loss to understand why the manufacturer should not be paid for such on the basis of their respective values, and in the same manner as with his anthracene.

A COUNTRY TAR DISTILLER.

BENZOL TESTING.

To the Editor of the Chemical News.

SIR,—When I wrote you my letter (CHEMICAL NEWS, vol. xliii., p. 115), I had unfortunately not read Mr. Staveley's letter in a previous number, otherwise, in deference to his opinions, I should probably not have called the process he defends a stupid one. I must say, however, that if I wished to prove to anyone that the process is anything but satisfactory, and that the term which I used was a justifiable one, I could not do better than refer him to Mr. Staveley's defence of it (page 129). It is admitted that the object of the process is to find the percentage of distillate which comes off, from any sample of benzol, at a given temperature—say 100° C. Mr. Staveley says that he distilled a sample of benzol, and did not allow the temperature to rise above 97° C., and he obtained 37 per cent of distillate, which even then had not ceased to come over; *but*, he says, this sample of benzol only contained 31 per cent of benzol distilling at 100° C. Why does he say so? Because he finds that percentage by his own process. This kind of reasoning reminds one of a man who assumes his watch to keep perfect time, so that if the earth made its complete revolution in twenty-five hours by his watch, that would prove that the earth had been an hour too long on its journey. I do not, however, condemn the process because it does not estimate accurately that which it purports to estimate, because such a process may be justified on the plea that it gives the same results in the hands of any one testing the same sample. Now let us see whether this is the case. I again refer to Mr. Staveley's letter. He says, in effect—I taught a certain chemist how to make the test, and he went away charmed with its simplicity, and repeated it in his own laboratory. Did his result agree with that which Mr. Staveley obtained? No, says Mr. Staveley, it did not. Well, one would naturally say, With such a simple process, carried out in the way so graphically described by Mr. Staveley, that the difference would be trifling. Not at all, is the reply; the difference amounted to between 20 and 30 per cent; or, as Mr. Staveley more pointedly puts it, the chemist he instructed "was wrong" to that extent. Now what is the cause of this extraordinary difference? Probably the unfortunate chemist had not attended to all the points which were necessary to obtain a result precisely similar to the one Mr. Staveley obtained; in other words, "the correct results." Perhaps the capacity of his retort was greater or less than that used by Mr. Staveley; perhaps the glass of the retort was too thick or too thin; the flame used too big or too small; the condenser too long or not long enough. All these things, I understand from Mr. Staveley's letter, make a difference; and in this Mr. Bettel, another of your correspondents on the same subject, confirms him. Mr. Bettel also resents the insult which I offered the process, and he also defends the method, only he says in effect, he doesn't use it. He does not put the flame directly to the bottom of the retort in accordance with the details of the process printed on the contract note to which I referred. He knows better than that, and has a method of his own for heating with hot air. As regards my question about placing the thermometer three-eighths of an inch from the bottom of the retort, I said in effect, if it be necessary to stipulate for that exact distance, why not stipulate also for the length of the bulb of the thermometer? Mr. Staveley's answer is conclusive: he says such differences at three-eighths of an inch and 1 inch in thermometer bulbs do not exist. In reply to that I may say I have a number of ordinary thermometers is use in my laboratory, the bulbs of which vary in length from three-eighths to one-and-a-half inches.

By assertions similar to that about thermometer bulbs does Mr. Staveley dispose of your correspondent "J. D.," who ventured to make a few remarks about the effects of barometric pressure on the percentage of benzol distillate. "J. D." said he had made accurate observations on this

matter. Mr. Staveley does not say he has done so, yet he ventures not only to contradict "J. D.," but to do so in a jocular manner.

The process which I suggested had for its aim the application of a fixed degree of heat, which cannot be obtained by two persons working with naked lamps, and if the only objection Mr. Staveley has to the process I suggested be the length of time required for the distillate to come over, let him add some common salt to the water, and he will find he can not only distil as quickly as he does by his present arrangement, but that if he teaches anyone how to work such a process, he may rely upon the results obtained by himself and his pupil not being very different. If a solution of salt be objected to, then the same apparatus, used as an air-bath, with a mercurial arrangement for regulating the temperature may be employed. At all events, I think Mr. Staveley has clearly proved in his last letter that a new process which would give reliable results in the hands of anyone is advisable, if not absolutely necessary.—I am, &c.,

WILLIAM THOMSON.

Royal Institution, Manchester,
March 29, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 10, March 7, 1881.

Reciprocal Displacements of the Hydracids.—M. Berthelot.—The action of the hydracids upon the salts formed by the halogens is in general the inverse of that of the elements themselves. Thus hydriodic acid expels hydrochloric acid from the metallic chlorides and hydrobromic acid from the bromides, whilst hydrobromic acid also liberates hydrochloric acid from the chlorides. The chlorides in general are decomposed by hydrobromic acid, and this decomposition preponderates according to the thermic value of the principal action. But the bromides may also be decomposed, though less readily, by hydrochloric acid. This inverse action previously pointed out by M. Hautefeuille in the salts of silver at a red heat, and by the author in the moist way, has lately been observed anew by M. Potilizine, but it is in no way contrary to thermo-chemical principles. It results from the existence of secondary compounds, partially dissociated, which intervene with their peculiar heat of formation. The theory of these reciprocal actions and equilibria is always the same. In every case we have to do with a principal reaction, foreseen by the thermic theory, and a perturbation equally foreseen by the same theory, of which it is a necessary confirmation.

Presence of Trichinæ in Pork Imported from America.—M. Bouley.—The author considers that there is little danger of trichinosis in France, as the meat is never eaten raw or imperfectly cooked.

Presence of Alcohol in the Soil, the Water, and the Atmosphere.—A. Muntz.—The author has previously shown that it is possible to detect exceedingly slight traces of alcohol by converting it into iodoform. On concentrating the alcohol in a small volume of water by means of fractionated distillation, and using the microscope to verify the presence of iodoform, he was able to recognise with ease 1·300,000th of alcohol mixed with water. He has since improved the process so as to detect quantities even smaller than 1·1,000,000. During the last four years he has applied this method to river-, spring-, and sea-water, as well as to rain and snow. The results obtained leave no doubt of the presence of a neutral body, more volatile than water, and yielding iodoform. He thinks alcohol is the hydro-carburetted body present in the atmosphere, indicated by the researches of Boussingault and De Saussure. Soils rich in organic matter yield alcohol in such proportions that its essential properties may easily be verified.

Circular Double Refraction and the Normal Production of the three Systems of Fringes of the Circular Rays.—M. Crouillebois.—The author has previously (*Comptes Rendus*, Feb. 7, 1881) described a method of obtaining simultaneously three normal systems of fringes of the elliptical rays. He now points out a procedure for obtaining the same result for the three systems of fringes of the circular rays.

Widening of the Rays of Hydrogen.—C. Fievez.—The nebulous expansion of the spectral rays of hydrogen, noticed on increasing the pressure of this gas in a Geissler tube, is still ascribed to the influence of the pressure, though Dr. Schuster, Secchi, and others have shown that it is not possible to alter the pressure of a gas without at the same time affecting the resistance of the medium, and in consequence the temperature of the spark which traverses it. The author has undertaken to examine separately the influence of the different agents, temperature, pressure, direction of the current, &c., which have been suggested as contributing to produce this phenomenon. He finds that the widening of the hydrogen rays is correlative to the rise of temperature. We may affirm that the temperature of a celestial body is higher than that of another if its hydrogen rays are broader.

Certain Phenomena of Optics and of Vision.—M. Trève.—The author mentions the fact that the flame of a lamp appears brighter, and that a vertical shaft, a post, or mast is seen more distinctly through a vertical than through a horizontal slit, whilst a house, a landscape, or the disk of the sun or moon is perceived more clearly through a horizontal slit. He finds similar differences in photographs according as the light passes from the object to the plate through a vertical or a horizontal slit, and ascribes the results to the action of diffused light.

Solubility of Silver Chloride in Hydrochloric Acid in Presence of Water or of Sparingly Soluble Metallic Chlorides.—F. Ruyssen and E. Varenne.—For increasing volumes of a silver solution the solubility of the chloride remains constant. The addition of water though weakening the acid does not lessen the solubility of the chloride in the same proportion. The action of other metals is favourable to solution, but in a very slight degree.

Heats Liberated in the Combustion of Certain Substances of the Saturated Fatty Series.—W. Louguinine.—The author has studied from this point of view, capronic acid, caprylic alcohol, trimethyl-carbinol, and pinacone.

The Transformation of Glucose into Dextrine.—F. Musculus and A. Meyer.—The dextrine obtained is the γ of Musculus.

An Active Amylamine.—R. T. Plimpton.—The author has obtained an amine having rotatory power and possessing properties different from those of the inactive amylamine described in *Comptes Rendus*, xci., p. 433.

Active Propyl-glycol.—J. A. Le Bel.—The author has submitted propyl-glycol to fermentation, and has obtained a lævo-rotatory modification along with propionic and lactic acids.

No. 11, March 14, 1881.

This number contains the account of the annual public session of the Academy for the award of prizes.

Reimann's Färber Zeitung,
No. 42, 1880.

Dr. A. Müller-Jacobs describes his improvements in Turkey-red oils. He admits that the use of pyroterebic acid is not absolutely essential.

Two curious receipts are quoted from a journal not named:—"Juch's preparation of chrome-yellow. Boil 4 lbs. pure white lead with 1 lb. bichromate of potash and 10 lbs. water. A considerable quantity of ammoniacal gas is evolved." "Aniline-blue resists even the action of direct sunshine. It is obtained from a mixture of aniline hydrochlorate with liquid chlorous acid."

The editor inserts a communication from "Bollington, near Macclesfield, Nottingham," on the rubbing off of vat-blue stockings.

No. 43, 1880.

The bicarbonate of soda prepared by the Solvay process contains from 2 to 3 per cent ammonia, and is therefore not suitable for pharmaceutical use, and for certain technological purposes.

The sulphuric anhydride of the Freiberg works is now in the market.

No. 44, 1880.

This number contains nothing of general interest.

No. 45, 1880.

The colouring-matters of wine are said to be identical with those of the bilberry.

No. 46, 1880.

In this number the chief article is a comparison of the respective advantages of zinc and of copperas for the prevention of boiler-incrustations.

No. 47, 1880.

This issue contains nothing of general interest.

Biedermann's Central-Blatt für Agrikultur-Chemie, August, 1880.

Conduction of Rain-water along the Trunks of Trees.—Dr. W. Riegler.—The quantity of water which finds its way to the ground in this manner is very considerable, but varies much according to the kind of the tree.

Influence of Hilling upon the Temperature and the Moisture of Arable Land.—Prof. E. Woolny.—Soil heaped up around plants has a higher average temperature than the level ground, but it becomes colder in the night. It dries more rapidly.

Manurial Inefficacy of Phosphoric Acid on the Experimental Field at Grignon.—Prof. Dehérain and Meyer.—The conclusions reached are that phosphates produced no effect on the experimental field at Grignon; that the soil contained a notable proportion of phosphates soluble in acetic acid. The question is raised whether such a soils hould receive further supplies of phosphoric acid.

Manurial Experiments with Sugar-Beets.—A. Dudouy.—The author concludes that potash has had an injurious effect, whilst phospheric acid proved inactive.

Experiments with Artificial Manures on Beets.—H. Pogge-Roggow.—The experiments were made with Peruvian guano and bone-dust. These manures increased the crop, but not to the extent sufficient to cover the extra cost of manuring.

MISCELLANEOUS.

Royal Institution of Great Britain.—Lecture Arrangements after Easter, 1881:—Lecture hour, 3 o'clock p.m. Prof. Dewar, M.A., F.R.S., Six Lectures on the Non-Metallic Elements; on Tuesdays, April 26 to May 31. Prof. Tyndall, D.C.L., F.R.S., Six Lectures on Paramagnetism and Diamagnetism; on Thursdays, April 28 to June 2. Prof. H. Morley, Three Lectures on Scotland's Part in English Literature; on Saturdays, April 30, May 7, 14: One Lecture on Thomas Carlyle; on Tuesday June 7. E. C. Turner, Esq., Lector at the University of St. Petersburg, Five Lectures on The Great Modern Writers of Russia; on Saturdays, May 21, 28, June 4, Thursday, June 9, and Saturday, June 11. The Friday Evening Meetings will be resumed on April 29th, at 8 p.m. Prof. J. S. Blackie, F.R.S.E., will give a Discourse on "The Language and Literature of the Scottish Highlands," at 9 p.m. Succeeding Discourses will probably be given by The Hon. G. C. Brodrick, Mr. Francis Galton, Mr. W. H. Pollock, Prof. H. E. Roscoe, Prof. W. G. Adams, and Prof. Dewar. To these meetings Members and their friends only are admitted.

MEETINGS FOR THE WEEK.

Monday, 11th.—Medical, 8.30.
—— Royal Geographical, 8.30.
Tuesday, 12th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
Wednesday, 13th.—Microscopical, 8.
Thursday, 14th.—Mathematical, 8.

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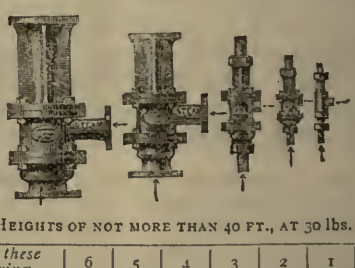

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THE CHEMICAL NEWS.

VOL. XLIII. No. 1116.

ON THE

COEFFICIENTS OF EXPANSION OF THE DI-IODIDE OF LEAD, PbI_2, AND OF AN ALLOY OF IODIDE OF LEAD WITH IODIDE OF SILVER, $PbI_2.AgI$.*

By G. F. RODWELL, F.R.A.S., F.C.S., Science Master in Marlborough College.

THE author having referred to his previous papers on the coefficients of the iodides of silver and mercury, and of certain chloro-bromiodides of silver, continues the same methods of determining the coefficients of the iodide of lead, and of an alloy of the iodides of lead and silver. Various alterations in the apparatus, which by the diminution of friction and other means have rendered it much more delicate than before, are described. The iodide of lead was found to possess three coefficients of expansion; the first for temperatures between 0° and 205° C.—

0·00008317 cubical expansion for 1° C.;

the second, a very high coefficient, between 205° C. and 253° C.—

0·0006378;

and the third, for temperatures between 253° C. and the fusing point—

0·000180.

The volumes at the different temperatures are given and tabulated, and the curve of expansion is plotted.

The lead silver iodide is next examined.

It contains in 100 parts:—

Iodide of lead ..	66·206	Lead ..	29·7449
Iodide of silver ..	33·794	Silver ..	15·5642
		Iodine ..	54·6909
	100·000		100·0000

Between 0° and 118° C., it slowly expands when heated with a cubical coefficient for 1° C. of

0·0000306.

Then for a few degrees (118 to 124° C.), it simply absorbs heat without contracting or expanding. On reaching a temperature of 124° C., the mass commences to contract on further heating, and this continues until a temperature of 139° C. is attained. Details of the contraction are given, and the curve of contraction is compared with that of the iodide of silver. Between 139° and 144° C., heat is again absorbed without change of volume; and above 144 C. the alloy expands somewhat rapidly, with a coefficient of

0·0001150.

The volumes at various temperatures between 0° and the fusing point are given, and are shown in a curve.

The following points are noted in regard to the alloy:—

1. It possesses a similar density at three different temperatures, as at 0° C., 130° C, and 282° C.

2. Although it contains only 33·794 per cent iodide of silver, it contracts as considerably *during heating* as the iodide of silver itself.

3. While the iodide of silver commences its contraction at 142° C., and finishes it at 145·5° C., the alloy commences to contract 18° C. lower (viz., at 121° C.), and finishes 6·5° C. lower (viz., at 139° F.).

4. The chloro-bromiodides of silver (*Proc. Roy. Soc.*, vol. 25, p. 292) also began to contract on heating (an effect which, of course, we must attribute solely to the presence of iodide of silver), at 124° C., but they finished at 133° C.

5. The harsh sounds emitted by the alloy during cooling, and the tremors simultaneously propagated through the mass, prove that violent molecular agitation is going on at such time as the iodide of silver is passing from the amorphous plastic condition to the brittle crystalline condition, within the mass of the iodide of lead.

6. The fusing-point of the alloy is 125° C. lower than that of the iodide of silver, which constitutes one-third of its weight, while it is only 19° C. higher than that of the iodide of lead, which constitutes two-thirds of its weight.

7. If the lowering of the fusing-point (also markedly apparent in the case of the chloro-bromiodides of silver) is due to the fact that similar particles of matter attract each other more powerfully than dissimilar, and hence, when the particles of two bodies are mutually diffused, the attraction becomes less, and the molecular motion is consequently more readily assimilated; the same cause may serve to explain the commencement of the phase of contraction on heating the alloy at a temperature of 18° C. lower than the substance to which it owes this property.

The lead silver iodide alloy is finally compared with a chloro-bromiodide of silver, which latter, although it contains 8 per cent more of iodide of silver than the lead-silver iodide alloy, undergoes a contraction on heating, which is more than twenty times less, although in both cases we must regard the effect as solely due to the iodide of silver.

* Abstract of a Paper read before the Royal Society, March 31, 1881.

ON THE

DETECTION OF ANILINE COLOURS IN RED WINES BY BROWNING'S MICRO-SPECTROSCOPE

By H. MACAGNO.

To a natural red wine diluted with one or two volumes of water, on adding a little of acetic ether, œnolin is slightly dissolved, and the supernatant fluid observed in a wedge-shaped cell with Browning's micro-spectroscope, no defined bands appear in the spectrum, but a very weak and hazy absorption from F to the end of violet takes place. This absorption does not interfere with characteristic bands of red or violet aniline colours, which absorb the rays of the complementary part of spectrum.

Fuchsin, safranin, and methyl-violet—commonly employed in adulteration of wines—are very readily soluble in acetic ether; so that by spectroscopical examination of this fluid, defined characteristic bands make their appearance in different parts of the spectrum.

Thus are seen the absorption-spectra of these substances in their pure state or mixed with one another. I indicate by < the rays (expressed by wave-length), between which bands are produced. The figures written at the side of vertical lines indicate two interposed rays, between which the greatest intensity of absorption takes place:—

Fuchsin.	Safranin.	Methyl-violet.
5775<	5586<	6100<
5625 |	5460 |	6000 |
5490 |	5362 |	5892 |
5425<	5175<	5817<

Fuchsin and Safranin.	Fuchsin and Methyl-violet.	Safranin and Methyl-violet.
5775<	5586<	5586<
5625 |	6050 |	6050 |
5490 |	5892 |	5892 |
5290<	5850<	5850<
	5667<	5625<
	5586 |	5586 |
	5525 |	5525 |
	5362<	5400<

The last two spectra give two bands almost equally placed, but they differ in their intensity. The lower band at the termination of the orange is darker and better defined than that in the green, when one observes a mixture of safranin and methyl-violet. The contrary takes place with fuchsin mixed with methyl-violet.

By this process the presence and quality of aniline colours can be detected and determined in a few minutes. Wines containing a very little quantity of these matters (0·005 grm. per litre), and so little that it certainly would be of no importance for commercial purposes, give very clean and characteristic spectral bands.

Agricultural Station of Palermo, Italy,
March, 1881.

ON THE ESTIMATION OF FAT IN MILK.

By WILLIAM M. HAMLET, F.C.S.,
Late Public Analyst for the Borough of King's Lynn.

The amount of fat present in milk is a factor so necessary to the solution of the problem of adulteration that a rapid and easy method of obtaining the result is an object of no small importance.

Since the early days of food-analysis a number of methods for the accomplishment of this purpose have from time to time been published: these may be classed as follows:—

I. Methods based upon the action of solvents on the undried sample.
II. The extraction of the fat from the dried milk in an open dish.
III. Extraction from the residue in closed vessels.

I.

The first method of this kind was proposed by Macnamara, in 1873, who sought to remove the fat from the milk in its original condition, but it never came into general use, being in practice found more complicated and less certain than the other methods. MM. Salleron, Vogel, Reischauer, and Marchand, each in turn improved upon the process, that of the latter chemist, although requiring specially-graduated apparatus, being on the whole the most successful. A full account of Marchand's process will be found in the excellent manual of Bolley and Kopp. But Méhu (*Journ. Pharm. et Chemie*, [4], xxix., 16 to 18), after having made an investigation as to its merits, pronounces it to be of value only as a preliminary test.

Lehmann (*Liebig's Annalen*, clxxxix., 358 to 367) allows the milk to flow over a porous tile resting on a vessel containing strong oil of vitriol, the fat being afterwards dissolved off by means of ether. I have never yet succeeded in finding a porous tile that would absorb the water present in milk to allow of anything like an approach to the real amount of fat.

Soxhlet (*Dingler's Polyt. Journ.*, ccxxxii., 461) recommends a method of extraction by ether after the milk has been partially dried by the aid of anhydrous sulphate of lime. He adds 20 grms. of dry gypsum to 10 c.c. of milk to hasten the desiccation and afterwards treats with ether. I cannot say I liked the process, and after three trials I found it afforded no better nor more rapid results than the well-known methods.*

II.

The best of the foregoing processes are not to be compared for general convenience with the class of methods I am about to describe, namely, those where the solids obtained on evaporating a given volume of the milk are digested with a solvent.

To Prof. Wanklyn we are indebted for the first systematic and reliable mode of analysing milk, the working of which is now so well known. In his book on "Milk Analysis," pp. 20 and 21, he recommends that the residue from 10 c.c. of milk, contained in a platinum dish of 40 c.c. capacity, should be first disintegrated with a few drops of alcohol, and then repeatedly boiled with ether, the ethereal extract being poured on to a small filter, dried, and finally weighed. Prof. Church, in commenting upon this process (*Laboratory Guide*, p. 219), very tersely says: "No one who has tried the method here recommended would adopt so clumsy, dangerous, and ineffective a plan." In justice, however, to the author of the process, it should be known that with a desire to make the method as practicable as possible Prof. Wanklyn advised certain precautions to be taken. In the Chemical News, vol. xxix., p. 3, he says:—"The operations are, first of all, the drying up of a small quantity of milk, and afterwards the boiling of the residue with ether; and a vessel, which is alternately an evaporating basin and a flask, is exactly that which is called for. These conditions are fulfilled as follows:—A thin platinum dish capable of holding 50 c.c, is employed, and in it the portion of milk (5 or 10 c.c. accurately measured) is evaporated to dryness. The dish during this evaporation is heated in the water-bath, which consists simply of a beaker half-filled with water, which is boiled over a lamp. The milk, as it is being evaporated, may be stirred with a small glass rod or small platinum spatula. The milk residue, having been obtained in a state of tolerable dryness, is covered with 20 or 30 c.c. of ether, and a *small inverted funnel* is fitted moderately tightly into the platinum dish, which is thereby converted into a flask. The further details are obvious. By the adoption of this apparatus the determination of fat in milk becomes perfectly easy."

Wynter-Blyth ("Manual of Practical Chemistry," p. 46) advises the same precautions to be taken, with the additional improvement, however, of a Liebig's condenser. By such means the process is much improved, but those who are called upon to make frequent analyses of milk will be inclined to agree with the observations of Prof. Church notwithstanding.

III.

The remedy proposed by Church was to scrape out the dry residue from the dish, reduce it to a powder, and transfer to the extraction-apparatus figured on p. 200 of his "Laboratory Guide."

I found, as a result of my own experience, that, however careful one might be, some loss inevitably occurs, owing to traces of the residue adhering to the dish. In order to avoid errors from this source I used to weigh the residue before going on with the extraction, and calculate the result upon the milk evaporated. Thus I obtained pretty good results, but with an extra expenditure of time and labour.

Of the many methods I have tried, and I believe they include nearly all that have been published, I find none so ready and at all times so effective as the one I will now describe.

The chief feature of this process consists in breaking or cutting up into small pieces the dish in which the milk has been evaporated. The dishes I employ are made of very thin blown glass, and measure 2¼ inches or 5·5 centimeter in diameter, and not more than ½ inch or 12 m.m. in depth. In default of these I have many times substituted common watch glasses 2 inches in diameter—the thinnest I could select. But a little dish made of thin copper or aluminium foil will answer equally well. The shreds and cuttings, or the broken pieces, if of glass, are simply transferred to the extractor, and the fat removed by any convenient solvent. I prefer to have the solids in a granulated condition, brought about either by stirring or by adding alcohol or acetic acid. Any of the various extraction-apparatus may be used. A most convenient one consists of an upright Liebig's condenser, to which is

* Since this paper was written a full account of Dr. Soxhlet's improved process has appeared (Chemical News, vol. xliii., p 101), which, up to the present moment, I have had no chance of trying. It certainly seems an advance upon his older method, and is made upon the milk direct and without previous evaporation.

attached a tube 6 inches or 15 centimetres long and ⅝ths to ¾ inch or 15 to 20 m.m. in diameter. At the upper end of the tube a funnel is fused on* having a diameter of 2½ inches or 6 centimetres for the purpose of transferring the solids quickly and without the slightest loss. The lower end of the extraction-tube is drawn out to a small bore, and receives a sound cork, previously boiled in water. To this is fitted a small flask of known weight.

The Process.—10 c.c. of the milk at 15·5° C. is accurately measured and allowed to run into one of the thin glass dishes previously described—a metallic foil or glass dish. These should have been previously laid dry upon the top of the steamer, and the milk poured in without having to remove the dish until the milk has evaporated to dryness. The residue, which will be dry in about an hour, is then placed in a 4½-inch shallow mortar, glazed on the inside and having a good lip. A clean linen cloth is placed over the pestle and mortar to prevent ejection of the pieces, and the dish is crushed up into pieces small enough to enter the tube. A few carefully-directed blows with the pestle will reduce the dish and residue to pieces about ¼ inch across without fear of the slightest loss. Of course if the dish be a metal one, a pair of scissors obviously replaces the mortar. Now lay a plug of cotton- or glass-wool in the lower part of the tube, and transfer the residue along with the bits of broken dish. Another plug of wool and the tube is packed and ready to be attached to the condenser by a cork. In four exhaustions every trace of fat is removed from the residue. My plan is now to attach the flask to another Liebig's condenser inclined at about the usual angle, and distil the ether off by means of a beakerful of hot water. By this means the same ether with trifling loss does over and over again. All that now remains is to warm gently on the water-bath, and then dry in the water-oven until constant, which may be done in two weighings with an interval of half an hour. The following examples show what may be expected of the process with ordinary care:—

A.—A sample of milk was employed, which yielded by Wanklyn's method 2·92 grms. of fat per 100 c.c. milk.

No. 1. ..	10 c.c. gave	0·2990	grm.
No. 2. ..	,, ,,	0·2985	,,
No. 3. ..	,, ,,	0·3001	,,
No. 4. ..	,, ,,	0·2989	,,

B.—A sample of watered milk, yielding only 1 88 grms. per 100 c.c. by Wanklyn's method.

No. 1. ..	10 c.c. gave	0·1890	grm.
No. 2. ..	,, ,,	0·1895	,,
No. 3. ..	,, ,,	0·1891	,,
No. 4. ..	,, ,,	0·1897	,,

The process is equally accurate with the residue obtained from even 5 c.c. of milk—the quantity originally suggested by Wanklyn.

The following were all dried in common watch-glasses—C.—

No. 1. ..	5 c.c. gave	0·1144	grm.
No. 2. ..	,, ,,	0·1140	,,
No. 3. ..	,, ,,	0·1146	,,
No. 4. ..	,, ,,	0·1144	,,
No. 5. ..	,, ,,	0·1139	,,

10 c.c. of the same sample of milk employed in series C.—

No. 1. ..	10 c.c. gave	0·2288	grm.
No. 2. ..	,, ,,	0·2287	,,
No. 3. ..	,, ,,	0·2290	,,

5 c.c I find upon the whole the most convenient volume to work upon, and I need scarcely say that greater care must be observed in measuring such a small quantity or serious discrepancies are sure to follow. The delivery-volume of the pipette must be accurately ascertained at 15·5° C., and the milk *always measured at the same temperature*. Stale milk must be weighed, never measured.

With regard to the observation of Geber, who advises that the casein should be first precipitated before proceeding to estimate the fat, and to Ritthausen, who employs cupric acetate or sulphate for the same purpose, I may remark that these reagents, as well as acetic acid, make no perceptible difference in the results. Granulation or disintegration of the solids by alcohol or stirring with a little acetic acid appears to favour the action of the ether, but for all ordinary purposes the residue may be made to yield all its fat without disturbance of any kind. The process is well adapted for the estimation of small amounts of fat, and I employed it with the greatest success in the analysis of some chylous urine, where a very accurate estimation of the fat was necessary.

In conclusion I hope that in placing these observations before the readers of the CHEMICAL NEWS the above process will be found to fulfil those two most desirable conditions in the work of a chemist, namely, accuracy and despatch.

* This is not absolutely essential, as the residue may be transferred in the same way that an ordinary combustion-tube is filled. But there is no room for doubt as to which is the best plan.

METHODS FOR JUDGING OF THE WHOLESOMENESS OF DRINKING WATER.*

By REUBEN HAINES.

MANY years ago, the usual way to ascertain the wholesomeness of drinking water was to discover what mineral impurities were present. The water was therefore evaporated to dryness, and a more or less complete analysis was made of the solid mineral substance left, as is done with mineral-spring waters. Little attention was given to the organic matter, except when present in very large amounts, as in marsh water, &c. Occasionally, even now, we read of some one making tests for mineral impurities in a suspected well water, but omitting any test for the organic matter. Such analyses were exceedingly troublesome; and, after all, it is very doubtful whether they were of much value—in many cases perhaps of no value whatever, in ascertaining the wholesomeness of ordinary drinking water. Of course, the detection of iron and of sulphate of lime and magnesia, in this way, was of some importance, for waters containing considerable amounts of these substances should be considered unwholesome for daily use, in health. But we really have no reason at all for supposing that such mineral substances as silica, alumina, potash, and soda, as they occur in any but very rare cases, have any influence whatever on health. Moreover, waters which are free from much mineral salts may often be very unwholesome for other reasons not discoverable at all in this way. This sort of analysis has therefore been entirely discarded by chemists conversant with recent sanitary experience, except in selecting a new source of water supply for a city, which involves other than sanitary interest as well.

In the preceding lecture it was shown that by far the most important element in sanitary investigations of water is the organic matter contained in it, either in the form of minute suspended particles or in actual solution. It was shown that the purest rain and spring waters contain a minute amount of organic matter, but that rivers, streams, and shallow wells in populous districts, contain much larger proportions of it. It has long been known that waters, the sources of which originate in populous districts, were often the apparent cause of disease.

These facts have been for many years recognised by chemists, and it has therefore been their endeavour to devise methods for finding the exact amount and also the

* Abstracts of lectures delivered before the Franklin Institute, December, 1880, in which additional original has been introduced. From the *Journal of the Franklin Institute*, February, 1881.

nature of this organic material. Let us now briefly review the advances which have been made in this direction.

The earliest method used for this purpose was what is known as the "ignition" process. It consisted in evaporating a measured quantity of water to dryness at a temperature which varied with different chemists, and weighing the residue. This residue was then exposed in a platinum dish to a sufficient heat to burn away all the organic matter. On cooling, the weight was again taken, and the difference was called organic matter. It was very simple, and easily performed, and was extensively practised. It has been shown, however, to give very erroneous results in a large number of cases, especially with hard waters and well waters containing considerable nitrate. There are numerous chemical objections to it which render it entirely fallacious, but it will not be proper on the present occasion to enter into much chemical detail. We may say, however, that any carbonates of lime, &c., will, by the heat necessary to burn away the organic matter, partially lose their carbonic acid, ammoniacal salts will be volatilised, nitrates will be converted into carbonates by the carbon of the organic matter, these and other salts will lose water of crystallisation, and if much chloride of sodium is present, in contact with carbon, hydrochloric acid will be volatilised, the fumes of which are often perceptible in thus treating the residue of a highly polluted water. Moreover, it is frequently difficult to get rid of the last traces of unconsumed carbon without raising the intensity of the heat so as to render the loss of mineral salts positively certain. In fact, we can never know what interchanges may take place among the materials of the residue when heated to faint redness. Various efforts were made to avoid this, or to replace the loss. Carbonate of soda was added during the first evaporation, but it has been shown that by this means a part of the organic matter was liable to be destroyed before the first weight was taken. Carbonate of ammonia, or carbonic acid water was added to the residue after being heated, so as to restore the lost carbonic acid, but while this confessedly replaces only a part of the loss, it has also been shown that the weight of the residue is frequently increased in a curious and irregular manner by this means, so as finally to become sometimes considerably greater than it was before being heated at all.

Prof. Wm. Ripley Nichols finds this method, with the employment of aqueous carbonic acid, of some utility for the relative comparison of the very soft waters of many New England streams. In these cases the loss appears to represent chiefly organic matter, and is recorded as "organic and volatile matter," which is the only accurate designation for it. But the results probably can never be, constantly, very exact, and no reliance should be placed upon them to the exclusion of other tests. In the case of the majority of well waters, Prof. Nichols considers this method valueless. It may frequently be useful, and as a qualitative test only, to heat the solid residue, and notice the odour, if any is given off. This will aid us in distinguishing animal from vegetable substances.

The unsatisfactory character of the "ignition" method led chemists to adopt what is known as the "permanganate" method. Of this there are numerous modifications, giving different results according to the practice of different chemists. They are all based on the same general principle, which is strikingly illustrated by the action of potassic permanganate on oxalic acid in solution. The magnificent colour of the permanganate almost instantly dissappears in a surprising manner. If we pour very rapidly, numerous bubbles of gas rise and burst at the surface, exactly as in a glass of soda water. Now, what happens here is, chemically, just as truly combustion as the burning of coal in a fire, only the oxidation takes place in water instead of air. The permanganate is rich in oxygen, which it gives up very readily, and this combines with the oxalic acid to form carbonic acid and water, just as the oxygen of the air unites with the burning coal to form the same substances. The oxalic acid is destroyed and the resulting carbonic acid gas passes off in small bubbles. The permanganate also is destroyed, as is shown by the disappearance of colour, and the hydrated oxide of manganese, which would otherwise settle in brown particles, is held in solution by sulphuric acid, a little of which was previously added, forming the colourless manganese sulphate.

Now oxalic acid is only one of the organic substances upon which potassic permanganate acts in the same way, in a greater or less degree. As long as there is organic substance in the liquid to be acted upon, the colour of the permanganate will be destroyed, although, in some cases, very slowly; but as soon as this organic substance is exhausted the pink colour will remain permanent in the liquid. We obtain in this way a sort of measure of the amount of organic substance. In the actual analysis the chemist takes a measured quantity of the sample of water and pours into it from a measuring-tube, called a burette, a solution of permanganate of known strength. This is a very imperfect description of the method, but it is sufficient for our pupose.

This method, with whatever modification it is used, does not really show how much organic matter is actually present, but only how much oxygen has been required by the substances which are capable of being oxidised in this way. German chemists are in the habit of reckoning five times the numbers obtained in the analysis as representing the total amount of "organischer substanz." This is, however, an arbitrary factor, and while it may have been tolerably accurate for some waters used as test analyses, we have no proof at all that the calculation would be accurate in all other cases, and it is hence reduced to a mere guess.

There are many objections to this method which show it to be very unreliable. Different substances are acted upon in very different degrees by permanganate, and upon some that must frequently occur in polluted water there is no action at all. Hence the method cannot by any means be relied upon to give the absolute amount of organic substance. If nitrous acid, ammonia, hydrogen sulphide, or protoxide of iron are present in the water they will affect the permananate in the same way as organic matter, and would be counted as such in the analysis. We must, therefore, find the amount of these substances in other ways and make a correction for them. It is also stated to be uncertain whether the action on ammonia is uniform, and if it is not, no accurate correction for the ammonia can be made. Dr. Frankland, while condemning this method as entirely unreliable for ascertaining the *quantity* of organic matter, admits that it may be a useful *qualitative* test. "Thus," he says, "if a clear and colourless water decolourises much of the permanganate solution the water ought to be rejected for domestic use, as being of doubtful quality." It has the advantage of being readily performed, as a qualitative test, in a short time, with few materials and no special apparatus, and is therefore useful on occasions when there is no opportunity for a regular analysis.

In the hands of any one chemist, its use as a quantitative method will, without doubt, give some valuable information as to the relative quality of different waters, if the test is always performed in the same manner. The degree of rapidity with which the oxidation takes place will probably give some idea as to the putrescible nature of the organic matter. It is thus that Dr. Tidy's periodical analyses of the metropolitan water of London, by the permanganate method, have not been without value.

In England and America both the methods I have described have been to a great extent abandoned, and two other methods have taken their place. These are Wanklyn's ammonia method, and Frankland's combustion method, which were devised and published at nearly the same time in 1867 and 1868. The Frankland process consists in evaporating a measured quantity of water to dryness and burning the residue in a combustion-tube on the same principle as that by which an organic analysis

is made. The resulting gases instead of being immediately absorbed are measured in a delicate and complicated apparatus for gas analysis, and then separated by absorption. The gases resulting from the organic matter are chiefly carbonic acid and nitrogen, and are calculated as organic carbon and organic nitrogen. The gases are drawn out of the combustion-tube by means of a Sprengel vacuum pump, and upon the perfection of the vacuum produced depends, in part, the reliability of the results.

The Wanklyn method, which is much more generally practised, makes use of the potassic permanganate. A measured quantity of the water to be analysed is put into a glass retort, to which is attached a condenser. A little carbonate of soda is dropped in through the stoppered orifice in the retort, and the water is distilled rapidly until no more ammonia is given off, and condensed with the steam. The distilled water is collected in flat-bottomed test-tubes of perfectly colourless glass. This ammonia which is first distilled is called free ammonia. It is that which is present in the form of ammonia, either in the free state or in combination, in the water. A solution of potassic permanganate, with which a strong solution of caustic potash has been mixed, is now poured into the retort, and the distillation continued until no more ammonia is perceived in the distilled water. The ammonia now found in the distillate is called "albuminoid ammonia," and is that which results from the decomposition of nitrogenous organic matter by the action of the permanganate solution. Hence it represents that organic matter, and forms a relative, more or less definite, measure of it. It is upon this peculiar action of a boiling, strongly alkaline solution of potassic permanganate that the method of Wanklyn is founded. The delicacy of the method depends upon the sensitiveness of the Nessler test for ammonia, which is one of the most delicate colorimetric tests in the whole range of analytical chemistry, being capable of recognising easily one part of ammonia in ten million parts of water, and distinguishing differences of one-third of this amount.

Let us now consider some of the defects of these two methods of analysis and appreciate what may be really learned by their use.

In the first place, by neither of them can we, with certainty, estimate the exact amount of organic matter actually present in water. For this purpose there is no method known; nor can these methods enable us to identify and separate the different kinds of organic substances that may be present. In fact, we know almost nothing as to their nature, except that there is a general impression that much of this polluting material is probably of an albumenoid character.

Frankland's method endeavours to estimate the exact quantity of organic matter, but as will be seen by a candid examination of the essential defects of the process, there is at least a formidable array of probabilities against the possibility of its doing this.

Wanklyn, on the other hand, does not undertake to estimate the absolute quantity, but simply attempts to find a factor by which to make a tolerably accurate comparison of the relative purity or impurity of water. By this method we analyse a naturally good water, known beforehand to be wholesome by long experience and absence of any contaminating source, and the results obtained from this are then taken as a *standard* by which to compare other waters. The opinion is expressed by some chemists that this standard, although practically constant for any one locality, will be apt to vary considerably for different localities, even remote from the seaside.

In comparing the two methods we may say that both are philosophical in some points, and both unphilosophical in other ways.

That of Frankland seems theoretically better, because a combustion is made of the organic matter on precisely the same principle that is employed in the ultimate analysis of an organic compound. By this means the carbonaceous matter not nitrogenous is also estimated, which does not enter into the results of Wanklyn's method.

But Wanklyn's method is more philosophical, because it deals with the water itself, and not with merely the solid residue left after evaporating the water. We want to know what is contained in the water, or at least the properties of the water; but we do not necessarily need to to know what is in the residue, for it is at best only indirect evidence, and what is shown by it may be only partially true of the water from which the residue came.

The value of Frankland's process depends on the assumption that what is contained in the residue fairly represents what is contained in the water itself, deducting of course the nitrates, which must be got rid of in conducting this method. This is really an assumption which Frankland has never clearly proved to be a fact, and which Wanklyn and others, including German authorities, claim is a mistake. It has been shown by German chemists that an appreciable amount of organic matter is lost during the evaporation of the water, especially when originally volatile matter is present. Moreover, we have no knowledge as to whether volatile products may not be formed during the evaporation at the boiling temperature. Frankland endeavours to prevent the latter result by the addition of sulphurous acid, taking advantage of its antiseptic properties. This has, however, been shown to be quite objectionable, causing the inevitable loss of part of the organic matter through the formation of gradually concentrating sulphuric acid. It is claimed that the further addition of sodium sulphite will not sufficiently neutralise this acid; but whether this is correct or not may not have been proved. Several other technical objections* have been advanced against the method, which it will be unnecessary to quote here. Finally, the chances of error and the numerical corrections to be made are so numerous as to make this method quite complicated and difficult. It requires the chemist to be thoroughly skilled in the most delicate gas analysis, on account of the exceeding minuteness of the quantities to be measured, as compared with ordinary analysis. The apparatus is costly and fragile, and considerable time is required for each analysis. Skilful chemists might not consider some of these as really serious objections, but they will certainly prevent the general adoption of this method by City and State Boards of Health for sanitary purposes.

This method endeavours, also, to determine the character of the organic matter by the proportionate relation of the organic nitrogen to the organic carbon, this relation being found to be, by an average between wide limits, respectively, 1 : 11·9 for waters containing extract of peat, and 1 : 1 8 for sewage.

But Frankland has found that oxidation of peaty matter decreases the carbon, while oxidation of sewage decreases the organic nitrogen. "It is thus evident that the proportions of nitrogen to carbon in soluble vegetable and animal organic matters vary in opposite directions during oxidation—a fact which renders more difficult the decision as to whether the organic matter present in any given sample of water is of vegetable or animal origin."

Prof. Nichols quotes from Sander:† "Without a knowledge of the previous history of the water, the relative proportion (between carbon and nitrogen) is not available as a means of deciding as to the nature of the contamination; if, however, the previous history of a water is known, there is scarcely need of so particular an analysis in order to judge of its character."‡

It has been shown that in the case of very pure waters the experimental error may often be greater than the total amount of organic material to be estimated, and that in the case of waters containing readily decomposable nitrogenous organic matter, together with a large excess of nitrates, the accuracy of the results may be more or less vitiated by the efforts to get rid of the latter. Mr. Wigner

* *Vide Jour. Chem. Soc.*, Chemical News, &c.
† Prof. Nichols's paper in Buck's "Hygiene," vol. i., p. 303.
‡ "Handbuch der Offentlichen Gesundheitspflege," p. 230.

says that "supposing that the organic nitrogen yielded by the Frankland and Armstrong process were a positive quantity instead of a quantity needing a heavy correction for personal equation and for impurities in the chemicals used, yet the danger of error involved in the analysis, and the risk of contamination by atmospheric impurities, are in my opinion sufficient to prevent it from ever coming into general use; and unless generally used it is undesirable for reports which appeal to public sense and public understanding."*

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FROM FEBRUARY 21ST TO MARCH 19TH, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

March 21, 1881.

SIR,—We submit to you the results of our examinations of the water supplied to the Metropolis for the month ending March 19th.

The circumstances under which the examinations have been made and the precautions taken to secure trustworthy results are similar to those we have described in our previous reports, but the samples have been collected from different localities.

It will be noticed that as regards turbidity and colour a great improvement has taken place in the Metropolitan waters since the date of our last report. The suspended matter has sunk to an insignificant amount, and in most cases is entirely absent.

For some time past we have been experimenting on methods of determining the colours of water, and we have this month adopted a process which, whilst it does not pretend to absolute accuracy, is a great improvement over the arbitrary "degrees of tint depth" by which the colour of water has hitherto been estimated. The process briefly is as follows:—

Two hollow wedges are filled one with a brown and the other with a blue solution,† and these are made to slide across each other in front of a circular aperture in a sheet of metal. In this way any desired combination of brown and blue can be produced. Each prism is graduated along its length from 1 to 40, the figures representing millimetres in thickness of the solution at that particular part of the prism.

On a level just below the prisms is a two-foot tube containing the water under examination, and having in front of it a circular aperture of the same size as the one in front of the prisms.

The stand supporting the prisms and tube is placed horizontally in front of a uniformly lighted window. The observer, standing a little distance off, sees two luminous disks, the lower one illuminated by light which has passed through two feet of the water, and the upper one illuminated by light which has passed through the respective thicknesses of the brown and blue solutions.

By sliding the prisms sideways one way or the other it is easy to imitate with considerable accuracy the depth and tint of the colour of the lower disk. A metal pointer affixed over the centre of the upper disk shows on the prism scales the number of millimetres in thickness through which the light has passed to produce a colour which corresponds to that of the water, and the results are recorded in the following way—Brown : Blue. Thus, "February 21st (New River), 20 : 21 means that on that date the colour of New River water seen through a two-foot tube was represented by 20 millimetres of brown and 21 millimetres of blue solution.

In Table I. we have recorded the analyses in detail of samples, one taken daily between February 22nd and March 19th. The purity of the water in respect of organic matter, has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

In Table II. is recorded the colour by the method above described, together with the clearness or turbidity of each sample. Of the 168 samples collected by us between the dates mentioned above, 144 were found "*clear*," 21 were noted as "*very slightly turbid*," and 3 as "*slightly turbid*."

Of the 24 samples supplied by the New River Company, the whole were clear, bright, and efficiently filtered.

Of the 24 samples from the mains of the East London Company, 5 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 24 samples from the mains of the Chelsea Water Company, 1 was noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 24 samples from the mains of the West Middlesex Company, 1 was noted as "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Lambeth Water Company, 8 were noted as "very slightly turbid," and 3 as "slightly turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Grand Junction Company, 4 were noted as "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 24 samples from the mains of the Southwark and Vauxhall Company, 2 were noted as "very slightly turbid." The remainder were clear, bright, and efficiently filtered.

If a trace of suspended matter be noticeable, we record the water as "turbid." If on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid." A water is recorded as "slightly turbid" when we consider it to come between those two extremes.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen in the whole of the samples collected.

We have already called attention to the great improvement that has taken place in the appearance of the Metropolitan waters since the date of our last report, and we have now to record our opinion that, taken as a whole, they leave nothing to be desired in respect of efficient filtration, wholesomeness, or complete aëration.—We remain, Sir, your faithful servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

* *Sanitary Record*, October 19, 1877.

† The solutions are made in the following way:
Brown Solution.—Dissolve ferric chloride and cobalt chloride in distilled water in such proportion that one litre of the solution contains 0·7 grm. of metallic iron, and 0·3 grm. of metallic cobalt. A very slight excess of free hydrochloric acid must also be present.
Blue Solution.—Dissolve 10 grms. of pure crystallised sulphate of copper in one litre of distilled water.

Preparation of Glycolic Acid from Sugar.—H. Kiliani.—Levulose and dextrose in aqueous solution are oxidised by silver oxide to glycolic, oxalic, and carbonic acids, even at common temperatures. Cane-sugar is reduced with the aid of heat, but mere traces of glycolic acid are formed unless the sugar has been previously inverted.—*Liebig's Annalen.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday April 7th, 1881.

Dr. Russell in the Chair.

The following certificates were read for the first time:—T. P. Venable, A. J. Shilton.

The Chairman then called on Mr. W. Jago to read a paper "*On the Organic Matter in Sea-water.*" On p. 133 of the "Sixth Report of the Rivers Commission" it is stated that the proportion of organic elements in sea-water varies between such wide limits in different samples as to suggest that much of the organic matter consists of living organisms, so minute and gelatinous as to pass readily through the best filters. At the suggestion of Dr. Frankland, the author has investigated this subject. The water was collected in mid-channel between Newhaven and Dieppe by the engineers of the London, Brighton, and South Coast Railway in stoppered glass carboys. The author has used the combustion method, the albumenoid ammonia, and in some cases the oxygen process of Prof. Tidy. To determine how the various methods of water-analysis were affected by a change of the organic matter from organic compounds in solution to organisms in suspension, some experiments were made with hay-infusion. The results confirm those of Kingzett (*Chem. Soc. Journ.*, 1880, 15), the oxygen required first rising and then diminishing. The author concludes that the organic matter of sea-water is much more capable of resisting oxidising agents than that present in ordinary fresh waters, and that the organic matter in sea-water is probably organised and alive. Several tables accompany the paper. The author promises some further work on the subject.

In answer to Mr. Piesse, the author stated that no determinations of phosphoric acid were made.

Mr. W. M. Hamlet then read a paper "*On the Action of Compounds Inimical to Bacteria Life.*" After criticising the experiments of Crace-Calvert (Chemical News, vol. xxii., p. 281), in which the solutions were exposed freely to the action of the air, and were in some cases even allowed to dry up, the author details his method of experimentation. Flasks similar to those of Pasteur ("Etudes sur la Bière," p. 81), holding about ½ litre, were used. The liquids employed were Pasteur's fluid with sugar, beef-tea, hay infusion, urine, brewers' wort, and extract of meat. Each flask was about half filled, and boiled for ten minutes, whereby all previously existing life was destroyed. The flask was then allowed to cool, the entering air being filtered through a plug of glass wool or asbestos. The flask was then inoculated with a small quantity of previously-cultivated hay solution or Pasteur's fluid. Hydrogen, oxygen, carbonic oxide, marsh-gas, nitrogen, and sulphuretted hydrogen, were without effect on the bacteria. Chlorine and hydric peroxide (about 7 per cent of a 5 vol. solution) were fatal to bacteria. The action of various salts and organic acids in 5 per cent solution was tried. Many, including potash, soda, potassic bisulphite, sodic hyposulphite, potassic chlorate, potassic permanganate, oxalic acid, acetic acid, glycerin, laudanum, and alcohol, were without effect on the bacterial life. Others—the alums, ferrous sulphate, ferric chloride, magnesic and aluminic chlorides, bleaching-powder, camphor, salicylic acid, chloroform, creosote, and carbolic acid—decidedly arrested the development of bacteria. The author has made a more extended examination of the action of chloroform, especially as regards the statement of Muntz, that bacteria cannot exist in the presence of 2½ per cent of chloroform, which substance is therefore useful in distinguishing physiological from chemical ferments. The author concludes that amounts of chloroform, phenol, and creosote, varying from ½ to 3 per cent, do not destroy bacteria, although their functional activity is decidedly arrested while in contact with these reagents To use the author's words, bacteria may be pickled in creosote and carbolic acid without being deprived of their vitality. The author concludes that the substances which destroy bacteria are those which are capable of exerting an immediate and powerful oxidising action, and that it is active oxygen, whether from the action of chlorine, ozone, or peroxide of hydrogen, which must be regarded as the greatest known enemy to bacteria.

Mr. Hamlet, in replying to some remarks of Messrs. Kingzett and Williams, said that in all cases the solution which he had used had been completely sterilised by exposure to a temperature of 105° for ten minutes. The india-rubber tubing he had used was steamed. Carbolic acid solution must contain at least 5 per cent of carbolic acid to be fatal to bacteria. He was quite aware of the importance of distinguishing between the action of the substances on various kinds of bacteria, and was quite prepared to admit that a treatment which would be fatal to one kind of bacterium might not injure another.

The Society then adjourned to April 21st, when a paper "On the Estimation of Hydric Peroxide by Means of Potassic Permanganate," by W. E. Adeney, will be read.

PHYSICAL SOCIETY.

Saturday, April 9, 1881.

Prof. W. G. Adams in the Chair.

Prof. Helmholtz was elected an Honorary Member o the Society, and Dr. James Moser an Ordinary Member.

Dr. J. H. Gladstone read a "*Note on Thermal Electrolysis,*" by himself and Mr. Alfred Tribe. The authors found that when sheet silver was plunged into fused silver chloride, or iodide of silver, crystals of silver formed on the sheet. Similarly, copper immersed in fused cuprous chloride, had copper crystals deposited on it; and when zinc was placed in melted zinc chloride, or iron in melted ferrous chloride, these two metals crystallised on the plates. They found this to be due not to a difference in the physical condition of the rolled metals, but to the unequal heating of the different parts of the immersed metals. By the contact theory of Voltaism there will be a difference of potential between the metal and the liquid chloride in contact with it, and this difference of potential will vary with temperature. Since all parts of the immersed metal cannot be supposed at the same temperature always, there is the possibility of a current being set up, and consequent electrolysis of the salt. This view was corroborated by heating the metal unequally, when a crop of crystals appeared in the cooler part of the liquid. Again, two silver rods connected together were plunged, the one in a hotter, the other in a cooler part of fused silver chloride, and at the end of fifteen minutes the latter was studded with crystals of silver, whilst the former was clean. A galvanometer showed a stronger current between the rods the greater the difference of temperature between the parts of the fluid in which they were placed, and transposing the rods reversed this current. These experiments bear on the nature of voltaic action, and form a lecture illustration of the conversion of heat into electricity and chemical force.

Mr. W. H. Walenn stated that he had found, when zinc is immersed in an electro-brassing solution, crystals of brass (*i.e.*, zinc and copper) were deposited on it.

Capt. Abney exhibited a number of photographic negatives, taken by himself and Col. Festino by radiation through thin sheets of ebonite. The light from the positive pole of an electric lamp was sent through a thin sheet of ebonite, 1-64th inch thick, and photographs taken showed the radiation to have a low wave-length from 8000 to 14,000. The carbon-points of the lamp could be photographed through the sheet, and Col. Festing observed the sun's disk through it. The ebonite showed a grained

structure, and different examples of ebonite gave different results, but all gave some result in course of time at least; old ebonite, like that used in some of Mr. Preece's experiments, scattering the light more than new ebonite.

Dr. MOSER exhibited the passage of the rays through the ebonite to the audience, by means of a galvanometer.

Prof. GUTHRIE observed that Capt. Abney had proved that light as well as heat traversed the ebonite.

Dr. COFFIN stated that the composition of ebonite, apparently the same, might vary considerably, and hence its transparency might vary too.

Prof. HELMHOLTZ addressed the meeting on the Localisation of Objects by the Eyes. We estimate distance with one eye by the outlines of the more distant objects being covered by the nearer ones where they meet, and by the shadows thrown by the anterior objects. These conditions are very rarely overpowered by others, as, for instance, binocular vision. This is shown by Dove's pseudoscope, and the fact that closing or blinding one eye makes little difference to the power of judging distance, especially when not very close to the eye. The relative shifting of objects as the eye is moved from side to side, or to and fro, or up and down, which may be called the parallax of motion of the head, is also a strong factor in estimating distance. The author had concluded from a study of the stereoscope that the perception of the absolute convergence of our eyes is very indistinct, and that only differences of convergence related to apparently near or distant objects produce the stereoscopic effect. More recent observations of his show that the incongruity between the degree of convergence and the parallax of motion is perceived with great accuracy.

Dr. STONE remarked that a person suddenly blinded in one eye acquires a new judgment of distance by moving the head (a habit seen in nocturnal birds); and in taking certain French stereoscopic pictures, the camera is shifted from one point to another, so that the combined images produce an impression of smallness in the object. These facts corroborate Prof. Helmholtz's view.

Mr. LEWIS WRIGHT pointed out that santonin, which changes the sense of colour, also appears to change the sense of distance.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Monday, February 21, 1881.

Mr. J. MACTEAR, F.C.S., F.I.C., President, in the Chair.

MR. J. J. COLEMAN, F.C.S., F.I.C., read a paper "*On the Removal of Aqueous Vapour from the Atmosphere.*" He said:—

The absolute weight of moisture contained in any given volume of air, and at any particular temperature, is usually calculated from a table of vapour-tensions by a formula well known to meteorologists, so that the accuracy of the results depend upon the care with which the table of vapour-tensions has been compiled from direct experiment. Fortunately for this as well as other branches of Physics, we have the exact experiments of Regnault, which, in the case in point, were carried down to about 20° below zero of Fahr. scale: but as at that temperature the tension of water vapour is only 0·017 of an inch of mercury, it is quite obvious that errors of experiment would be apt to increase to a serious extent in carrying observations to lower temperatures by the method adopted by this experimentalist. One of the earliest papers that the late Professor Rankine wrote was one on the "Elasticity of Vapours" (*Edinburgh New Philosophical Journal*, July, 1849), in which he says—"I have obtained amongst other results an equation giving a very close approximation to the maximum elasticity of vapour in contact with water," and from three constants—viz., the vapour-tension at 220° C., at 100° C., and at 26° C.—he calculated theoretically the vapour-tensions for every 10°—from 230° to 20° below zero, which corresponds almost exactly with Regnault's experiments. In reference to this formula, Prof. Rankine observed that it may be employed without material error for a considerable range beyond what he proved it, but that it can be only regarded as an approximation to the exact physical law of the elasticity of vapours for the determination of which many constants are still wanting which can only be supplied by experiment. The principal point involved in such an enquiry is the question as to whether aqueous vapour ceases to have elasticity at any point short of absolute zero. Passing, however, from such remote considerations, and directing attention to the absolute weight in grains per cubic feet of vapour at various temperatures, I have been led to notice the ratio in which vapour is liquefied by regular diminutions of temperature from 100° F. above zero down to zero itself. On the tabular statements accompanying this paper I have given two columns of figures, the first column up to half its length containing the actual weight in grains of a cubic foot of saturated vapour, as given in Glaisher's hygrometric tables, and for temperatures which decrease at the uniform rate of 10° down to zero. Directly underneath these figures I show the ratio in which the weight decreases for every drop of 10°. Thus saturated vapour, in dropping from 100° to 90° deposits 25 per cent of its weight; from 90° to 80°, 26 per cent of its weight; from 80° to 70°, 27 per cent of its weight, and so on, the ratio increasing almost uniformly at the rate of 1 per cent every fall of 10°; so that by the time the temperature gets to 10° above zero it parts with 35 per cent of its weight in falling 10° lower to zero. It seems reasonable, therefore, to suppose that some similar ratio of decrease will be maintained for temperatures far below zero, and in accordance with this view I have ventured to extend the line of figures to a temperature of 120° below zero, from which I have calculated the figures on the remaining half of the column above alluded to, thus showing the probable weight of a cubic foot of vapour for every 10° to 120° below zero.

	Temperatures.	Weight of cubic foot of Saturated Vapour in Grains.	Percentate of Weight Deposited for Fall of 10° in Temp.
Glashier's Tables above zero F.	100	19·84	25
	90	14·85	26
	80	10·98	27
	70	8·01	28
	60	5·77	29
	50	4·10	30
	40	2·86	31
	30	1·97	34
	20	1·30	35
	10	0·84	34·5
	0	0·55	35
Calculated below zero F.	10	0·36	36
	20	0·23	37
	30	0·14	38
	40	0·08	39
	50	0·05	40
	60	0·03	41
	70	0·017	42
	80	0·009	43
	90	0·005	44
	100	0·003	45
	110	0·0015	46
	120	0·001	47

The result can, of course, only be considered as an approximation, for in reality the ratio of liquefaction must be accelerated to ensure complete liquefaction at a point above absolute zero; but, at any rate, it is very clear that at a temperature of 120° below zero, a cubic foot of saturated aqueous vapour does not weigh more than the thousandth part of a grain, or 1-536,000 part of the weight of the same volume of dry air at 60°, or about 1·800,000 of the weight of a cubic foot of dry air at 120° below zero.

I have also thought it might be interesting to put the result in the form of a graphic curve, the vertical figures representing the weight of a cubic foot of vapour, and the horizontal figures representing the temperature commencing at 100° above zero, and ending at 100° below zero. One of the most curious facts that strikes the eye is the independent influence of the freezing-point of water upon this curve, although there is a little irregularity. There is no sudden deposition of moisture when the freezing-point is attained—ice, in fact, imparting humidity to air just as water had previously done before the freezing-point was attained. With a view to consider for a moment the joint effect of cold and pressure upon aqueous vapour, I have now to remind you of a well-known law of Physics, viz., that when saturated vapour is subjected to pressure it will liquefy in the direct ratio of the pressure, temperature being constant; and also that atmospheric air saturated with aqueous vapour behaves in this respect just the same as if the air were not present. This principle was illustrated by Dalton, who introduced volatile liquids into the Torricellian vacuum of a barometer tube, and showed that the liquids evaporated or recondensed in proportion to the elevation or lowering of the tube in a mercurial trough. Assume, then, that air at 60° F. and saturated with moisture is compressed to 20 atmospheres, and in a surface condenser consisting of a suitable system of tubes surrounded by an ample supply of water at the initial temperature of the air, then 19-20ths of the weight of that aqueous vapour should be deposited as dew in the inside of the pipes. If the volume of the air at starting were 1 cubic foot at 60°, then it would contain 5·8 grains of water, and when compressed to 20 atmospheres without change of temperature 5·5 grains would be deposited, and being expanded again to its original volume and pressure, out of contact with the deposited water, it would be found to contain only 3 grains of water. Going a step further, let us suppose that the same cubic foot of vapour saturated air at 60° is compressed into one-twentieth its bulk in another way, viz., in direct contact with water, —say by forcing it into a strong reservoir partially filled with water. Imagine the compressed air and water to be shaken together and then allowed to stand until perfectly quiescent, the temperature being kept at 60°: now let the water be carefully drained away, or detached from the compressed air, and the air be expanded to its former bulk, and it will be found to be drier than it was at the start, as it will have lost nineteen-twentieths of its vapour just as in the former case. Thus we are brought face to face with a curious paradox—that it is possible to dry air by wetting it. Both of the methods of drying air I have thus described are limited in practice by the difficulty on the one hand of getting temperatures under 100° below zero, and on the other hand, of compressing air in a continuous current to higher pressures than 20 atmospheres. But it is manifest that if the two operations be combined, air might be dried so as not to contain more than the 10,000,000th part of its weight of vapour. It is an interesting question how these figures compare with the result of desiccating air by chemical methods. According to H. C. Debbit (abstract of whose paper on the subject appeared in the *Journal of the Chemical Society*, October, 1876), anhydrous phosphoric acid is the most powerful desiccating agent, and he states that this substance will remove the 2,000,000th part of the weight of air in the form of moisture, even after it has been carefully dried by sulphuric acid at temperatures not exceeding 25° C. When the anhydrous phosphoric acid, he says, was made to act upon air which had been previously dried over sulphuric acid at 50° C. no less than the 1,000,000 part of its weight proved to be aqueous vapour. Calcium chloride seemed to be a worse desiccator than sulphuric acid, or at any rate its power of desiccation seems to be within very small ranges of temperature, as the author observes that if air be dried by passing over this salt at a given temperature, and be brought into contact with a fresh quantity of the salt at a lower temperature, a further absorption of water takes place, but that if the second portion of chloride of calcium be maintained at a higher temperature than the first the air becomes moister. In reference to this subject it may be interesting to refer to the paper of Professor Tyndall, recently read to the Royal Society, "Upon the Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter," in which he describes experiments made by passing radiant heat through flasks containing varying quantities of aqueous and other vapours. Tyndall shows that the more vapour there is present in air the more easily are the heat pulsations converted into audible noise on the principle of Graham Bell's recent discoveries. Dry air, in fact, gave no sounds whatever which could be detected, whilst minute quantities of many vapours added to the air occasioned sounds which could be compared in intensity with those of an organ pipe. Amongst other experiments he mentions that Prof. Dewar supplied him with four flasks, the first containing air dried by chloride of calcium, the second air dried by strong sulphuric acid, the third by Nordhausen acid, and the fourth by phosphoric anhydride: and, curious to say, the flask containing the phosphoric anhydride emitted the strongest sound, which is the exact reverse of what should be the effect if phosphoric acid were the best desiccant. Even with sulphuric acid, the extreme difficulty of drying air was very evident, for Tyndall remarks that air kept over the surface of this acid for twelve hours emitted sounds, which, however, entirely disappeared when the time of contact was increased to eighteen hours. This beautiful method of investigation will doubtless be followed up, and it is to be hoped will clear up many points connected with the relative efficiency of desiccants. In regard to the strictly mechanical method of drying air described in the first part of my paper, it has been to some extent practically carried out in the construction of Bell-Coleman cold-air machines used for the Oceanic conveyance of meat and other provisions. In these powerful machines, and of the size most usually employed in the Transatlantic traffic, about 36,000 cubic feet per hour of atmospheric air are taken into the air compressers; and supposing this air is two-thirds saturated, and of a temperature of 80° F., it contains 37½ lbs. water vapour, some of which must be removed before the air is finally discharged from the machine below zero, or the discharged air would become loaded with clouds of snow, which would be a great practical inconvenience. But in point in fact, about half this aqueous vapour is at once deposited, and mingles with the water which is freely injected into the compresser to keep down the heat produced by the compression, and escapes therefrom by a pipe controlled by a ball-cock before the compressed air is allowed to expand; it is made to traverse a great number of small pipes, the external surface of which are cooled by the waste cold air—say of 30°—coming from the provision room being refrigerated. So that by this means a very considerable cooling of the compressed air is effected, causing a further liquefaction of vapour, by which, in fact, its quantity is practically halved. Thus, by the time the air gets to the expansion cylinder, where expansion takes place in the act of doing work, the air, although it has been freely washed with fresh water, contains only about one-fourth of the aqueous vapour which it contained at the start of the cycle, and can be expanded without producing any inconvenient amount of snow. The temperature at the moment of expansion is generally from 30° to 50° below zero, or 100° below zero when the machine is worked at about four atmosperes of condensation. This method of producing cold dry air has not only been employed in cold-air machines working across the Atlantic, but has also been recently found to work well with machinery traversing the Red Sea and Indian Oceans.

A Result of the Cultivation of Flax in Saxony, and the Yield of Flax in Belgium and Westphalia.—Belgian flax loses 24 per cent in steeping, and that of Westphalia 30 per cent.—*Biedermann's Central-Blatt.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Biedermann's Central-Blatt für Agrikultur-Chemie, August, 1880.

Experiments on the best manner of Applying Artificial Manures to Potatoes.—Patow-Lalendorf.—Harrowing the manure in gave a better result than hoeing it in. Peruvian guano produced the heaviest crop.

Researches on the Reversion of Superphosphates.—M. A. Millot.—The author contends that in the analysis of superphosphates, not merely the soluble phosphoric acid (as customary in Germany and England) or the sum of the soluble and the reverted (as usual in France and Belgium), should be determined, but each of these forms separately. He finds that if mineral phosphates contain a considerable amount of ferric oxide, even if a sufficient quantity of sulphuric acid is used, a part of the phosphoric acid combines with iron, and forms phosphates insoluble in citric acid. Acid calcium phosphate behaves like phosphoric acid, bicalcium phosphate being formed; not, as Joulie maintains, the triphosphate. Alumina, at common temperatures, forms only phosphates soluble in citric acid. Calcium carbonate mixed with superphosphate combines with phosphoric acid, and even in an acid mixture there is a formation of bicalcium phosphate or of the tri-salt if the quantity of carbonate is sufficient. This reversion appears more considerable than it really is if neutral citrate is used instead of the ammoniacal.

Action of Artificial Manures upon Hungarian Wheat Soils.—A. Schumaker.—The manured plots gave in all cases heavier crops than the unmanured, but the financial result was distinctly unfavourable.

Determination of Reverted Phosphoric Acid with Ammonium Citrate.—A. Grupe, Prof. B. Tollens, Dr. Crispo, Prof. Petermann, and M. P. Chastaign.—Grupe and Tollens find that the calcium phosphates soluble in citrate are transformed into calcium citrate and ammonium phosphate, the former salt being soluble in an excess of the liquid. Not merely dicalcium—but to some extent tricalcium—phosphate is dissolved if it has not been very strongly dried. Phosphoric acid in ammonium-magnesium phosphate cannot be determined by this method. The solvent action of the citrate liquid is greater at 35° than at common temperatures. Threefold the calculated quantity of magnesia-mixture gives approximately accurate results. Crispo pronounces the method in need of improvement, and shows that the presence of calcium carbonate or magnesia in any form renders the phosphoric acid, which has been dissolved on treatment with ammonium citrate, insoluble again. Thus there is often found less phosphoric acid soluble in the citrate-liquid than in water. M. P. Chastaign finds too low figures for the phosphoric acid in superphosphates in presence of magnesia. He proposes to extract first with water, and then to treat with ammonium citrate—a suggestion with which Petermann agrees. He wishes to confine the determination of phosphoric acid soluble in water to dissolved guano and bone superphosphates.

Certain Relations between Muscular Activity and Decomposition of Matter in the Animal Organism.—Dr. O. Kellner.—The requirement of an organism for the exertion of energy can become a cause of the decomposition of the components of the nutriment and of the body. Non-nitrogenised materials are first attacked, and if such are insufficient or have been consumed a decomposition of the organised albumen takes place. This decomposition of the albumen of the body can only be arrested by an increase of food, especially of its non-nitrogenous portion. Even a very abundant supply of albumen cannot prevent the destruction of organised albumen if the total quantity of nourishment is not sufficient for the requirements of the force to be exerted. It is possible and probable that in consequence of the increased demand for oxygen during work a larger quantity of circulating albumen is necessary than the minimum required by the organism when at rest.

Experimental Production of the Fungus of Splenic Fever.—H. Buchner.—The genetic connection of the bacteria of splenic fever with the hay fungi and the possibility of the transformation of each into the other is completely proved. The author has not succeeded in producing splenic fever with the unmodified hay-fungus.

Solidity of Timber at Different Times of the Year.—Von Nördlinger.—The average resistance to pressure in the month of February is expressed by the number 5·40, whilst in August it reaches a minimum of 3·28.

Artificial Influence on the Difference of Development of the Upper and Lateral Eyes of Potatoes, and on the Conditions of the Formation of Tubers.—Dr. K. Kraus.—Not suitable for abstraction.

Cultivation of the Beets.—Prof. E. Wollny.—Not suitable for abstraction.

Wickersheim's Process for the Preservation of Organic Substances.—H. Struve and O. Jacobsen.—The original formula was 100 c.c. water, 40 c.c. glycerin, 10 c.c. methylic alcohol, 3·33 grms. alum, 0·83 grm. common salt, 0·40 grm. saltpetre, 2 grms. potash, and 0 66 grm. arsenious acid. The author points out that the alumina will be completely precipitated by the potash, and proposes in place of both alum and potash an equivalent quantity of potassium sulphate. The following two modifications of the fluid are now in use, the former for injections and the latter for steeping objects to be preserved:—

Arsenious acid	16 grms.	12 grms.
Sodium chloride	80 ,,	60 ,,
Potassium sulphate	200 ,,	150 ,,
Potassium nitrate	25 ,,	18 ,,
Potassium carbonate	20 ,,	15 ,,
Water	10 litres	10 litres
Glycerine	4 ,,	4 ,,
Common methylic alcohol	¾ ,,	½ ,,

Justus Liebig's Annalen der Chemie, Heft 2, 1880.

On Inuline.—H. Kiliani.—A very extensive memoir on the history, preparation, composition, behaviour, and derivatives of this substance.

Cinchonidine and Homo-cinchonidine.—O. Hesse.—A very complete account of these bases and their salts. The author has not succeeded by any method in converting homo-cinchonidine into cinchonidine, or in effecting the inverse transformation. He considers these alkaloids as distinct.

On Cinchonine.—O. Hesse.—The author considers the assumption of the presence of several cinchonines in the commercial preparation as inadmissible.

Optical Determination of Cinchonidine Sulphate in Commercial Quinine Sulphate.—O. Hesse.—The author considers that optical examination is the best method of detecting the cinchonidine salt. He describes certain improvements on his process given in *Annalen*, 182, p. 154.

Absorption of Oxygen by Pyrogallol in an Alkaline Solution.—T. Weyl and X. Zeitler.—The conclusion arrived at is that the absorptive power of pyrogallol in an alkaline solution is a function of the alkalinity of such solution.

Hydro-ferro-cyanic Acid in its Compounds with the Amines.—L. J. Eisenberg.—The author describes the acid dimethyl-aniline compound, the neutral, and the acid aniline salts, and the meta-toluidine, ortho-toluidine, and oxylidine compounds.

MEETINGS FOR THE WEEK.

WEDNESDAY, 20th.—Meteorological, 7.
THURSDAY, 21st.—Chemical, 8. "On Fractional Distillation (Part II.)," F. D. Brown. "On the Estimation of Hydric Peroxide by means of Potassic Permanganate," W. E. Admey. "The Oxidation of Sulphurous Acid," H. B. Dixon.
FRIDAY, 22nd.—Quekett, 8.

NOTICE.

LIVERPOOL.

MR. A. NORMAN TATE, in reply to several inquiries from clients and others, and to avoid further misconception arising from similarity of his surname to that of one of the principals of another Chemical Establishment in this City, whose announcements of commencement of business have lately appeared, desires to say that his only Office and Laboratories are in HACKIN'S HEY.

The publishers of one Magazine, evidently misled by similarity of surname, having mentioned him (as "Mr. Norman Tate") as one of the Principals of the Liverpool College of Chemistry, he desires to say that he is in no way connected with that establishment, and he has no Partner.

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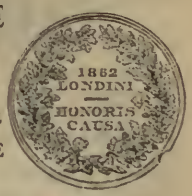

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THE CHEMICAL NEWS.

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ON THE ATTENUATION OF THE VIRUS OF CHICKEN CHOLERA.*

By L. PASTEUR.

Of the various results which I have had the honour of communicating to the Academy concerning the disease commonly called Chicken Cholera, I will take the liberty of recalling the following :—

1. Chicken Cholera is a virulent disease of the highest order.
2. The virus is a microscopical parasite, which may be multiplied by cultivation outside of the body of an animal.
3. The virus presents various degrees of virulence. Sometimes the disease is followed by death; at other times, after giving rise to morbid symptoms of variable intensity, these are followed by cure.
4. The difference noted in the power of various viruses are not merely the results of observations made of natural phenomena, for the experimenter can give rise to them at will.
5. As generally happens with virulent diseases, chicken cholera does not recidivate, or rather it may be said that recidivation is in inverse ratio to the intensity of the first attack of the disease, and it is always possible to carry the preservative action far enough to prevent the most virulent virus from producing any effect.
6. Without wishing to affirm anything at this time on the relations of the virus of variola to that of vaccine, there appears from the foregoing that in chicken cholera there are conditions of the virus which, relatively to the most virulent virus, act as human vaccine to the virus of variola. Vaccine virus gives a mild disease, but preserves from a more serious disease, variola. In the same manner the virus of chicken cholera presents, in certain conditions, an attenuated virulence which gives the disease but does not cause death; and after cure has been effected, the animal may without danger be inoculated with the most virulent virus. There is, however, a great difference between these two sets of facts, and it must be acknowledged that in some respects the advantage is with investigations relating to chicken cholera, as far as knowledge and principles are concerned; for while discussions continue on the relations of vaccine to variola, we possess the assurance that the attenuated virus of chicken cholera is derived from the very virulent virus proper to this disease, that we may pass directly from one form of the virus to the other. This fundamental nature of each is the same.

The time has come for me to give explanations concerning the main fact of the preceding prepositions, which is that there are variable states of virulence in chicken cholera. This must certainly seem a strange result if we bear in mind that the virus of this affection is a microscopical organism, which may be cultivated in a state of perfect purity, as might be done with beer yeast or with the mycoderm of vinegar. If we reflect on this mysterious problem of variable virulence, we are led to think that this characteristic is probably common to the various species of this group of virulent diseases. Where is, then, the distinctive character which belongs to these diseases? To cite only one example :—We often see very severe epidemics of variola, and others of a milder type, without the possibility of ascribing these differences to the variable conditions of climate or of individual constitutions. We also see great contagia become gradually extinct, to reappear again and again to become extinct.

The idea of the variable virulence of the virus is not, then, of such a nature as to surprise physicians and educated persons, but nevertheless it becomes interesting to establish it on scientific bases. In the particular case we have before us the mystery lies in this, that the virus is a microscopical organism, and that the degree of virulence depends on the observer. This I mean to establish beyond doubt.

Let us take as starting-point the virus of cholera in its most virulent form. I have already given a process for obtaining it with the maximum of virulence, which consists in taking it from a chicken that has recently died, not from the acute disease, but from the disease in its chronic form. This form sometimes presents itself, although rarely. The chicken resists the disease for weeks and even months. When it has died, which happens when the parasite, after being localised, finally passes into the blood, we may observe that whatever may have been the virulence of the virus originally inoculated, the virus from the blood of the animal who has taken so long to die is of such virulence that it kills in every case. If we make successive cultivations of the virus obtained in this way, in a pure state, in a broth made from chicken's muscles, by starting each cultivation from the preceding one, and if we make trials from each successive cultivation, we will find that the virulence does not vary in an appreciable degree. In other words, if we make this convention, that two cultivations have the same degree of virulence when on operating in the same conditions on animals of the same species the proportion of deaths is the same, we say that in our successive cultivations the virulence remains the same.

In what I have said I have not made any mention of the interval of time between the beginning of one cultivation to the beginning of the next, and of the possible influence of this interval on the degree of virulence. I will now call your attention to this point, although its importance may appear small. For an interval of from one to eight days, the virulence does not seem to change. For an interval of fifteen days, we have the same result. For an interval of a month, of six weeks, or of two months, there seems to be no diminution of virulence. Nevertheless, as the interval becomes greater there appear signs of little apparent value that the virus has become weaker. For instance, although the proportion of deaths remains the same, the rapidity with which chickens die does not seem to be so great. In the various series of inoculated chickens, some seem to linger, although very ill and sometimes very lame, as the parasite has settled in their thighs. The pericarditis is of milder type, and abcesses occur around the eyes. The disease seems to have lost its overwhelming character. We may make the intervals still greater: we may put three months, four months, five months, eight months between two successive cultivations. Then we obtain entirely different results, for the degrees of virulence, which formerly were not perceptible, now become well marked by apparent effects.

By such long intervals between successive seminations, it happens that the next cultivation does not present mortalities of ten for ten inoculations, but decreasing mortalities of nine, eight, seven, six, five, four, three, two, one for ten inoculations, and sometimes there are no deaths, which means that the disease shows itself on all the subjects inoculated, and they all recover. In other words: by simply changing the process of cultivation of the parasite; by merely placing a longer interval of time between successive seminations, we have obtained a method for decreasing virulences progressively, and finally get at a vaccinal virus which gives rise to a mild disease, and preserves from the deadly disease.

* Translated from *Comptes Rendus de Académie des Sciences* of October 25, 1880, by P. Casamajor.

We must not think that for all these attenuations things proceed with mathematical fixedness and regularity. A cultivation which has stood for five or six months without renewal may show remarkable virulence, while another may be considerably attenuated after waiting three or four months. We will very soon explain these irregularities, which are only apparent. Often even there is an abrupt passage from a condition of notable virulence to the death of the parasite for an interval of short duration. In passing from one cultivation to the next we are sometimes surprised to find that further development has become impossible. The parasite has died. The death of the parasite is an event which often occurs when sufficient time has elapsed after a new semination has been begun.

Now this Academy understands the true reason of the silence I have kept, and of the liberty I asked to delay information on my method for effecting the attenuation of the virus. Time was an element in my researches.

While the various phenomena are taking place, what becomes of the microscopical organism? Does its shape and aspect change, while its virulence is changing in such a marked manner? I would not dare to affirm that there does not exist certain morphological relations between the parasite and the various degrees of virulence which it shows; but I must confess that it has not been possible for me to seize them. If any such relations sometimes appear, they disappear again to the eye working through a microscope, on account of the extreme minuteness of the virus. The cultivations seem to be the same for all degrees of virulence. If sometimes slight changes are seen they seem to be entirely accidental, for in the next cultivation they either disappear or even sometimes inverse changes take place.

A remarkable circumstance is that if we take each variety of virulence as a starting-point from which to make new cultivations, at short intervals, each variety of virulence keeps its own intensity. If, for instance, we have an attenuated virus which can only kill once in ten times, it will keep the same degree of virulence in its successive seminations if the intervals are not too great. A very interesting circumstance, although in accordance with the preceding observations, is that an interval of semination which may be sufficient to cause the death of an attenuated virus has no sensible influence on a more virulent virus, although this may, in its turn, become afterwards attenuated to a marked degree.

Now that we have arrived at this point, a question presents itself which relates to the cause of the attenuation of virulence.

The cultivations of our virus must take place in contact with air, because our virus is aërobian, and, without air, its development becomes impossible. We are then naturally led to ask whether the attenuation of the virus is not due to contact with the oxygen of air. Would it not be possible that the small organism which constitutes the virus, when left in contact with the oxygen of pure air, in the medium of cultivation in which it has developed, may have been modified, and the change remains permanent, even after the organism has been withdrawn from the modifying influence? We may also enquire whether some chemical principle in the atmosphere, other than oxygen, does not intervene in this phenomenon, the singularity of which almost justifies my hypothesis.

It is easy to understand that the solution of this problem, in case it depends on our first hypothesis, that the phenomenon is due to the oxygen in the atmosphere, may be tried by experiment. If oxygen is in reality the cause of the attenuation of virulence, we may have, to a certain degree, a proof of it by noting the effect of suppressing it.

To test this, let us conduct our cultivations in the following manner:—We may take a certain quantity of our chicken broth, and place in it the most virulent virus, and fill with it a series of glass tubes up to two-thirds, three-quarters, &c., of their volumes. These tubes may then be closed over the lamp. By the presence of the small quantity of air left above the liquid the development of the virus may be started, which is ascertained by the increasing turbidity of the liquid. The development of the cultivation gradually absorbs all the oxygen contained in the tube. The turbidity then diminishes, the growth is deposited on the sides of the tube, and the liquid becomes limpid. This takes place generally in two or three days. The microscopic organism is then deprived of oxygen, and will remain in this condition as long as the tube is not opened. What will become of its virulence? To be sure of our results we will have prepared a great number of such tubes and an equal number of flasks, which last will continue to be left in contact with pure air. We have already spoken of what becomes of cultivations carried on in presence of air. We know that they experience a progressive attenuation of their virulence, and we will not return to this subject. Let us now only pay attention to the cultivations in closed tubes. Let us open them—one after an interval of a month, another after three months, and so on until we open one that has stood ten months. I have not gone any further at the present time. It is a remarkable circumstance that the virulence in all these cases is of the same degree as that of the liquid which served to fill up the tubes. As to the cultivation exposed to the air, they are found either dead or in a condition of feebler virulence.

The question we have proposed is then solved: it is the oxygen of the air which attenuates and extinguishes the virulence.

To all appearances we have here what is more than an isolated fact. We must have reached to a general principle. We may suppose that an action which is inherent to atmospheric oxygen, an agent present everywhere, has the same influence on other viruses. At any rate it is worthy of interest that possibly a general cause of attenuation exists dependent on an agent which is in a manner cosmical. Can we not suppose even now that it is to this cause that we can attribute in the present, as in the past, the limits set to great epidemics.

The facts which I have had the honour to communicate to the Academy suggest many proximate and remote inductions. From all these I must hold back with reserve. I will not feel authorised to present them to the public, unless I make them pass into the domain of demonstrated truths.

LABORATORY OBSERVATIONS.

By FREDERICK FIELD, F.R.S.

At the conclusion of "Laboratory Observations," in the CHEMICAL NEWS, vol. xliii., p. 75, it was stated that they had extended to the action of certain organic substances upon the rose colour, produced by the solution of platinic iodide in potassic iodide. The following notes may not be without interest. Solutions of starch, cane- and grape-sugar, gum, dextrin, gelatin, glycerin, nitrous and oxalic acids, and many other substances have no perceptible action upon the rose colour, even when they are highly dilute. Neither has urea nor uric acid; but urine, albumin, tannic, gallic, and pyro-gallic acids, potassic cyanide and sulphocyanide, and the liquids in which meat or vegetables have been boiled, destroy the colour with greater or less rapidity.

It occurred to me that these facts might have some value, as, although the results were not conclusive as to the actual existence of any one body in the liquid, the *negative* result, in this instance, viz., the non-change of colour, would be a tolerable certain evidence of the freedom of the added solution from substances possessing a deleterious influence. Thus, although the presence of gallic or tannic acids would cause the disappearance of the tint, albumin, urine, sewage water, and the water of wells near a cesspool would have a similar effect. The resistance of the colour to the influence of the liquid would prove the absence of all the above substances, whether baneful or harmless.

A solution was made containing one part of platinic chloride in 500,000 of a very dilute solution of potassic iodide. 50 c.c. of the liquid were placed in a series of wide glass test-tubes, and a similar volume (50 c.c.) of the following were added to each, and thoroughly mixed. The original solution had a clear bright rose colour.

Water from the Thames taken at high and low tide at Lambeth.—No great effect. There was a simple dilution of colour owing to the addition of the colourless liquids.

Water from the various London companies.—No perceptible changes, but in one or two instances the colour faded considerably in the course of twelve hours.

Water from the main drainage, after the sewer had been recently "flushed."—Speedy decolorisation.

Water from same sewer, having a slightly disagreeable odour.—Instantaneous destruction of colour, even when diluted with ten times its volume of pure water, *i.e.*, 5 c.c. of sewage to 45 c.c. water.

Water in which vegetables and meat had been boiled.—Similar result.

1 c.c. urine added to 49 c.c. water destroyed the colour after a few minutes.

1 c.c. solution of albumen prepared by dissolving the white of one egg in 200 c.c. water, immediately discharged the colour from the platinum salt.

Dilute solutions of gallic, pyro-gallic, and tannic acids.—Same reaction: as well as potassic cyanide and sulphocyanide.

Saliva also destroyed the colour.*

On the contrary—

Solution of	urea	No effect.
,,	uric acid	,,
,,	starch	,,
,,	gum	,,
,,	dextrin	,,
,,	cane-sugar	,,
,,	grape-sugar	,,
,,	glycerin	,,
,,	gelatin	,,
,,	oxalic acid	,,
,,	tartaric acid	,,
,,	citric acid	,,
,,	acetic acid	,,
,,	carbon disulphide ..	,,
,,	alcohol	,,

From the above experiments it would appear that many organic substances which speedily decompose potassium permanganate do not affect the platinum salt. As it was thought that the platinic iodide employed was rather too dilute, 1 part in 200,000, in place of 1 in 500,000, was employed. This solution has a rich ruby colour, and seems affected in the same degree, though, perhaps, not quite so readily. The reaction of a solution of albumen is by far the most striking of any of the results mentioned above. The splendid red tint on the addition of a few drops of that liquid instantaneously disappears. This would be a good lecture experiment, although by no means conclusive of the existence of albumen.

Such are some of the observations which have been made, and must be regarded merely *as* observations, having, perhaps, no great scientific interest in themselves. It may be, however, of some importance to the chemist to know that an equal volume of water added to a solution of platinum iodide of the strength above given, and retaining its colour, may be regarded as comparatively free from sewage contamination and from albuminous matters, although it may contain nitrites and nitrates. The water from wells, unfortunately near a cesspool, could thus be easily tested. The destruction of colour *might* give a false alarm; the retention of tint, would, to say the least, be consolatory.

* I am not aware that it is generally known that iron cannot be recognised in urine (the metal as a ferric salt) by means of potassic sulphocyanide, unless excess of hydrochloric acid is present. This must be due to the phosphates, which destroy the red colour. Potassium sulphocyanide exists in saliva, and it is a well-known experiment to add a drop of ferric chloride to that secretion and mark the characteristic tint. If a trace of sodic phosphate be present there is no change of colour, which is developed, however, on the addition of hydrochloric acid.

METHODS FOR JUDGING OF THE WHOLESOMENESS OF DRINKING WATER.*

By REUBEN HAINES.

(Concluded from p. 174).

Wanklyn's method is also unsatisfactory and unphilosophical as a scientific quantitative method, because it assumes that most of the organic material usually found in drinking water is in its general character similar to animal and vegetable albumin. This is an assumption which no one has yet proved to be correct, and it is difficult to perceive how it can be proved until we know definitely what these specific materials are, which it is impossible to determine in the present state of our knowledge. Wanklyn found that pure albumin yielded by this method about two-thirds of its total nitrogen as ammonia, and that this proportion was quite constant. That this is also true of organic matter in water cannot at present be proved. He proposed at first to calculate the total organic matter as ten times the albuminoid ammonia, but this he has since, evidently, and it should be said rightly, rejected as both unscientific and really not necessary for the practical judgment of the sanitary character of water by his method.

Those who are familiar with the most recent sanitary experience realise that it is the *quality* rather than the *absolute quantity* of organic matter that is the most important factor in the sanitary judgment of a drinking water. A water which contains a large amount of one kind of organic substance may be much more wholesome, or far less unwholesome, than that which contains only a small amount of another kind. It is a matter of actual experience that a water, notwithstanding it contains a large amount of nitrogenous organic matter capable of yielding albuminoid ammonia, may be found to be practically wholesome, or at least may be drunk for a long period without apparently producing any injurious effects; while, on the other hand, a water which contains *even a minimum* of organic substance capable of yielding albuminoid ammonia may nevertheless contain or develope the *materies morbi* or unknown causal "something" of a specific disease.

While Wanklyn's ammonia method is certainly a very easy and expeditious performance, yet great caution is necessary in the formation of an opinion from the analytical results; and thus it may frequently happen that serious mistakes may be made through hasty conclusions from insufficient data. It is said very truly that a really very bad water will rarely, if ever, escape condemnation, and an exceedingly pure water will undoubtedly be shown to be pure, so far as this is possible by any chemical investigation. But by far the larger number of well waters more especially lie between these extremes, and must take their place under the head of Doubtful Purity, and it is in the judgment of the latter that the analyst is liable to error, even to the extent of rendering an opinion diametrically the opposite of that of another chemist.

One of the precautions necessary to be taken in these, and in fact in all cases, is to avoid placing any *strict* reliance, for purposes of judgment, on the standards of purity which have been published in the treatise on "Water Analysis," by Wanklyn, and quoted in a number of recent works on Hygiene. It is impossible to lay down exact standards, or rules for judgment, which will hold good for

* Abstracts of lectures delivered before the Franklin Institute, December, 1880, in which additional original matter has been introduced. From the *Journal of the Franklin Institute*, February, 1881.

all countries and all localities in any one country. Such "standards" are, as Professor Nichols observes, only of relative value, and different kinds of water cannot be judged by the same standard.*

We must first of all discover, by numerous and carefully selected analyses, what are the chemical characteristics of good wholesome water in any given locality. These data then form a standard of purity for all waters of one kind within that particular district. A general knowledge of the geological and mineralogical character of the soil and rock of that region is an important factor in such a standard. A knowledge of the chemical character of the ground-water of the district, entirely free from any artificial conditions, such as polluted soil, is necessary for judgment of the well waters of the same district.

As regards different kinds of waters we must distinguish between

I. Ground waters, which include shallow well waters.

II. Deep well waters, including artesian wells.

III. Surface waters, such as rivers, streams, lakes, and ponds.

These three classes have essentially different characteristics, and one should not be compared with another without making proper allowances for these differences. It is thus incorrect to compare well waters near Philadelphia directly with the water of the Schuylkill river, as is sometimes done.

Upon reflection it will be readily understood that well waters are not commonly subjected to the oxidising influences to which river waters are so freely exposed, such as direct sunshine, air in motion over the surface, and aëration due to falls and currents in the river. Some mineral salts from factory refuse, from coal mines, &c., have possibly a modifying influence which is absent in the case of wells. Now there is a general feeling, among the medical profession and sanitarians, that organic matter which is more liable to rapid decomposition is more dangerous to health than more stable organic substances. In river waters there are greater chances for this decomposition to have been completed, leaving such substances as may be of the latter class in much greater proportion.

Hence, a larger amount of organic matter will be allowable in river water in the condition used for drinking than in well waters, provided that the supply is taken at a sufficient distance from the places where polluting material enters the stream.

Another point of importance in forming an opinion on the wholesomeness of a surface water is the natural character of its source. A river water which originates in peat bogs, or the tributary streams of which pass through a peaty district, will contain extract of peat in solution throughout its whole course. These waters certainly should not be compared, without qualification, with river waters which do not come in contact with peat, but nevertheless yield on analysis an equivalent amount of albuminoid ammonia derived from sewage contamination.

Thus, for instance, the water of Lake Cochituate, one of the sources of supply for Boston, probably contains considerable extract of peat, or other "vegetable extractive matter," which is, so far as we know, perfectly harmless in drinking water. So, also, is this the case, I believe, with the water of Jamaica Pond, which also supplies a part of Boston. Now, the Schuylkill river water supplied to Germantown, and taken from the river at Flat Rock dam, pumped at the Roxborough Water Works of Philadelphia, gave, according to my own analysis, during the the winter and summer of 1878, almost exactly the same results as Professor Nichols's analysis of the Cochituate and Jamaica Pond waters in 1873 and 1875 respectively, and with the same degree of variation at different times. But, while the analytical results are the same in both cases, a comparison of the general characters and sources of these waters convinces me that we cannot call the Germantown supply nearly so pure from objectionable organic matter as the Boston water. I think we may safely say that the Schuylkill contains no extract of peat, and the albuminoid ammonia undoubtedly comes from material which is far more objectionable. At times, also, since 1878, this albuminoid ammonia is as much as one-half greater than the largest amount from the Cochituate water in 1873, as supplied at the Massachusetts Institute of Technology, and nearly twice as great as the average amount of the latter. At such times the water has a perceptibly disagreeable taste and a slight odour, and this occurs usually when the water in the river is very low from drought.

In general, it may be said to be very necessary to know the exact source of any water submitted for analysis, the physiographical and geological characteristics of the locality from which it comes, and the location of any sources of pollution, such as cesspools, privies, drains, or sewers near the place of water supply. Whatever method of analysis is used, or in whatever way performed, the necessity of a knowledge of the previous history of the water is not diminished. Even with this knowledge, as is stated by Prof. Nichols, cases may arise in which an experienced chemist will be unable to give a decided opinion.

When the river water is pumped up into distributing reservoirs, the water from near the surface, and at the bottom of these reservoirs, should be submitted to analysis, to as to locate more accurately any trouble which may exist.

Furthermore, attention should be especially called to the fact previously referred to in this paper, that it is probably not so much the question as to how much organic matter, *per se*, may be consumed without danger in our drinking water. This point does enter, it is true, into the consideration. But it is *mainly* a question as to whether there is any danger of the water being contaminated with fæcal discharges from human beings suffering from infectious disease. It has been found that water containing so large a proportion of organic matter as to be called "loaded" with it may be drunk with impunity by some persons, or at least without any disastrous result being apparent for a long time; provided it does not also contain the "contagium" or unknown "something," whatever it may be, which will of itself develop specific disease. As soon as this "something" appears to be added by a previously diseased person an epidemic of this disease breaks out among those who consumed the water and who, until this time, remained apparently healthy.

Inasmuch as we have no means whatever of discovering the presence of this "contagium" because we know nothing of its character, any contamination with sewage is dangerous in proportion to its amount, and to the nearness of the pollution in time and place. Some authorities in Holland were once asked how much organic matter was allowable in drinking water without danger, to which they replied that drinking water should be, like Cæsar's wife, above suspicion. It may be laid down as a positive rule that a suspicious water is always a dangerous water.

The extent of dilution of the sewage in a river with a large body of moving water of good quality is undoubtedly an important factor, but this may be entirely counterbalanced by the fact of the water supply being taken very near a large sewer.

Upon these considerations lies the importance of the estimation of the nitrates and nitrites in a drinking water. These salts are among the results of the decomposition of organic nitrogenous matter, and are hence an evidence of what was either previously contained in the water, or which became oxidised by filtration through soil or by other means of decomposition before it reached the water. The greater the amount of nitrates above the natural limit, the larger the amount of organic material which has hitherto undergone oxidation, and hence the greater the danger, in the case of wells, of the soil becoming saturated and clogged with organic substance until a part of it will

* Prof. W. R. Nichols's paper on "Drinking Water and Public Water Supplies," in Dr. Buck's "Hygiene," vol. i, page 303.

escape filtration and pass unchanged into the water. Moreover, this part, which has escaped oxidation, may contain, for aught we know, the poison of a specific disease. Hence, it is important in order to form a correct opinion of the sanitary character of a well water, never to omit the proper tests for nitrates and nitrites, unless all the other quantitative tests concur in pronouncing the water pure. If any one of these gives a doubtful answer,-the nitrates should always be tested for, and if more than traces are present, it will be best to make a quantitative estimation of them. It is true that nitrate may, probably, also result from reduction of the true ammonia, but this fact does not render the estimation any the less important, for this ammonia itself, under ordinary circumstances, results from the decomposition of the organic matter, and in shallow wells is usually regarded as evidence of pollution with urine.

We should remember, however, that deep wells may furnish a very pure water, containing very little organic matter, but large quantities of free ammonia, chlorides, and nitrates, all present in the same sample, which are derived from certain kinds of soil, such as the sand beds beneath the London clay and about 250 feet below the surface."

Mr. Ekin† considers it necessary to estimate the amount of nitrates and nitrites in every instance, and states that a small increase in their amount should materially influence the judgment to be given. He states that he has been forced to this conclusion by facts ascertained in the course of his somewhat wide experience in the analysis of about 2000 samples of water, many of which were directly connected with cases of typhoid fever.

The estimation of nitrates, &c., in a river water, however, has manifestly not the same significance which it possesses in the case of well waters, on account of the superior influences effecting oxidation in the former, and the probable absorption of nitrates by aquatic plants. As regards *nitrites*, it is stated that delicate tests have not revealed their presence in the Thames river water.

In partial corroboration of the opinions of Mr. Ekin and Dr. Fox, as to the necessity of the estimation of nitrates, I will contribute a case in my own experience. I refer to the epidemic of typhoid fever in Spring Alley, or Royal Street, in the southernmost part of Germantown, which occurred last summer during the last week of July and first of August. There were upwards of forty cases, including four which proved fatal; and all, except one, were grouped in the immediate neighbourhood of a well situated at the intersection of two narrow streets. This well, known as the Spring Alley well, has had a wide reputation as a remarkably strong pure spring for, it is said, nearly a century. It is also said that typhoid fever never occurred in this locality before 1880. The well is only ten feet deep, the ground slopes down towards it from three sides, and a brick sewer passes within about ten feet of it, at about the same depth and having two badly choked up inlets directly opposite the well. An overflow drain connected the well directly with the sewer, *entering the latter near the bottom* at a short distance beyond the well. On the 5th of July a very heavy rain occurred, which deluged the vicinity of the well. As the sewer has, at this place, scarcely any fall it must have become suddenly clogged up with filth, and backwater must have occurred through the overflow drain directly into the well, polluting it, no doubt, to a very great degree. It was subsequently found by Dr. A. F. Müller, of Germantown, that a case of typhoid fever, probably imported from elsewhere, had occurred in a neighbouring house about six week before the heavy rain, and that the drain from this house connected with the sewer above the well. There were also other circumstances probably contributing to the pollution of this well. Another well, frightfully foul, but in no way connected with the sewer, being on higher ground, and the sewer lying between the two wells, increased, no doubt, the malignity of the epidemic. All the cases of fever developed at nearly the same time. The exceptional one, before mentioned, which did not occur close to the well, but at a house two blocks distant, was a child in a family who had sent to the first mentioned well for water, shortly after the pollution took place. All the people of the locality, and especially all those who had the fever, had used the Spring Alley Well, some of them continued to do so after the fever broke out, some had also used the water of the other well, but none had used the city from the Schuylkill until after the outbreak.

The chain of evidence thus seems unusually strong and clear. My analyses of this well-water were made during the prevalence of the epidemic and while new cases were developing. They are as follows:—

	I.	II.	III.	IV.
Free ammonia Pts. per mil.	0·034	0·010	0·010	0·058
Albuminoid ammonia „	0·116	0·080	0·090	0·140
Chlorine Grs. per imp. gal.	2·3	2·6	2·3	2·4
Total solids „ „	30·5	—	—	28·0
Nitrogen as nitrates and nitrites, Grs. per imp. gal.	—	1·94	—	2·45
Nitrogen as nitrites only do.	—	0·096	—	0·032

The samples were collected in the order of the numbers respectively, Aug. 10, 12, 13, and 21; the last three early in the morning and the first at noon. No. II. was taken nine hours after a heavy rainfall lasting one and a half hours. No. IV. was collected half an hour after a short but heavy shower. The water, nevertheless, remained quite clear. All the samples were bright and colourless, with no odour, and having a refreshing taste. The water was quite hard.

In order to judge properly of these analyses, I give, for the sake of comparison, analyses of a hard and of a soft water which are typical of the purest well-waters in Germantown and perfectly free from contamination:—

	Free NH_3.	Albuminoid, NH_3.	Chlorine.	Solids
Hard water ..	0·010	0·050	2 2	34·0
Soft water ..	0·014	0·034	0·7	6·0

The hardness in Germantown waters is due chiefly to sulphates. It will be noticed that the chlorine in the Spring Alley well-water was not greater than is usual in pure hard waters here. What is still more remarkable is that the other well in Spring Alley contained not a particle more chlorine, notwithstanding that enormous amounts of free ammonia (from 2·7 to 5·2 parts per million) were present, with large excess of albuminoid ammonia, and large amounts of nitrates and considerable nitrite. In these two cases, therefore, *freedom from excess of chlorine did not prove freedom from contamination by sewage*, according to the rule usually stated. Three privies stood close to the second well, hence the chlorine test was of no value at all in this latter case. It may be added that the test was repeatedly made with the same result.

The following well-waters of Germantown, which I analysed in 1878, are examples of what we may find in wells in highly dangerous situations, which tend to confirm Mr. Ekin's statement, that dangerous wells may contain a small amount of organic matter along with considerable nitrate, and that in such cases the opinion to be rendered will depend very much on the presence of the latter:—

	I.	II.	III.
Free ammonia Parts per mil.	0·040	0·022	0·016
Albuminoid ammonia „ „	0·046	0·058	0·080
Chlorine .. Grs. per imp. gal.	3·2	3·2	2·7
Nitrates	considerable.	large am't	
Nitrites	traces	—	—

Hardness in all these waters, about 12°, due to sulphates chiefly. The situation of the wells is as follows:—No. I., Mechanic Street west of Morton Street, in close proximity

* Dr. Cornelius B. Fox. "Sanitary Examinations," p. 140.

† "Potable Water. How to Form a Judgment on the Suitableness of Water for Drinking Purposes." By Chas. Ekin, F.C.S. London: 1880.

to a number of privies which are on somewhat lower ground; soil—loose, micaceous sand. No. II., Haines Street, near M. E. Church; pump on strect pavement, exposed to infiltration from gutter, &c. No. III., Haines Street, east of Hancock Street; well under kitchen porch. The owner felt anxious about it, and asked to have the water analysed. I have not heard of any sickness having been attributed to any of these wells.

The chlorine is very slightly in excess of the amount frequently found in pure hard waters of this district, and it would therefore by itself scarcely be considered a suspicious circumstance.

I will conclude this paper with the analysis by Professor Nichols of a well-water in Fairhaven, Massachusetts, published in the Massachusetts State Board of Health Report for 1879, which will be interesting in comparison with the foregoing analyses. It should also be stated that my analyses have shown that many other wells in Germantown are *far more polluted* than this one, particularly those in crowded localities.

Well in Fairhaven, Massachusetts.

Free ammonia	0·01 part per million.	
Albuminoid ammonia..	0·13 ,,	,,
Chlorine	3·3 ,,	100,000.
Total solids	20·3 ,,	,,
Nitrates	Not in larger amount.	

The privy vault was *one hundred feet* distant from the well. The soil was composed of gravel and loam. On the 7th of September the husband was taken quite ill with typhoid fever, and his dejections passed freely into the privy vault. On September 30, and during the next twelve days, his wife and six children were successively taken with typhoid fever, and another child took the same disease a few days later. Thus, every member of this one family who had used the water of the well were ill with typhoid fever. The water was probably poisoned by the excreta of the husband, and the usual incubative period intervened before the disease appeared amongst the rest of the family. The chlorine in the water was found to be one part per one hundred thousand, more than the natural amount for that locality. In order to compare it with that in the other analyses given above, multiply by 7-10ths to reduce to grains per imperial gallon. The date of the analysis was October 17, within a day or two of the development of the last case of fever.

NOTICES OF BOOKS.

The Fields of Great Britain. A Text-Book of Agriculture. Adapted to the Syllabus of the Science and Art Department, South Kensington, by Hugh Clements, with an Introduction by H. Kains Jackson. London: Crosby Lockwood and Co.

The introduction to this little work is not cheerful. "All classes," we are told, "are being shifted to a lower level as regards income. The world demands more work and time for money than was accepted in the early half of the present decade." This, we submit, is cold comfort for an already over-worked world. If it be true that human improvement demands prolonged concentrated thought, and that such thought requires leisure, there is here unfolded the prospect of a cessation of that progress in science and its applications which has been the boast of the earlier half of the present century.

This treatise is not confined to agricultural chemistry, but treats of soils and their formation, minerals, elements and their compounds, climatology, the distribution of vegetable species, drainage, implements and machines, farm-buildings, malting, hay-making, stock, and in short everything which an agricultural student may be expected to know, or at least to pass an examination in.

On the distribution of plants we find some peculiar statements. We read (p. 50) that "prickly shrubs and scanty grass are peculiar to Central Asia." We think the author, if he should ever visit certain districts of Australia and South Africa would find palpable proof that this assertion is too sweeping. Neither can we admit that dates are peculiar to Arabia or the palm to India. On the following page we read:—"The arctic, sub-arctic, cold temperate, warm temperate, sub-tropical, tropical, and equatorial regions, roughly correspond with (1) lichens and mosses; (2) birch, fir, and pine; (3) oak, wheat, and deciduous trees; (4) wine-grape (!), evergreen trees, &c.; (5) laurels, myrtles, coffee, sugar-cane, &c.; (6) fig, olive, tree-ferns; (7) palms, spices, and bananas. It seems to us that the groups 5 and 6 have been inverted. The fig, olive, and the tree-ferns certainly flourish farther from the equator than do coffee and the sugar-cane. On the same page we find an account of the climatic conditions suitable for wheat, which is almost identically repeated on p. 53.

Of sewage irrigation the author speaks, in our opinion, somewhat too favourably. He says, "the milk obtained from sewage grass has been found to be treble that from the unsewaged." But has he compared the qualities, and above all the respective keeping-powers?

Peruvian guano, we are told, yields about 16 per cent of ammonia, but this sometimes falls as low as 12 and even 9. We fear that latterly a cargo containing 16 per cent of ammonia could no longer be met with. The subject of the diseases and the enemies of our field- and garden-produce seems too slightly touched upon.

In the chapter on malting the author shows that this process does not increase the nutritive power of grain. Lucerne and sainfoin are described twice, p. 61 and again on p. 159. On p. 50 the fig is said to be peculiar to Arabia, but on p. 184 it is pronounced to be "a native of Asia, especially India." The author's remarks on the cultivation of fruits and the desirability of its increase in this country are timely and judicious. The same must be said of the section on the growth of forest-trees. In our weeping climate, indeed, we need not fear drought as a possible result of the deficiency of trees, but an increased amount of planting would reduce the sweep of the wind, which is one of the worst enemies of the farmer and the gardener.

Under the head "Food" we are told, "organic bodies are *sharply* divided into plants and animals." We must remind the author that according to eminent modern authorities it is often in individual cases extremely difficult to come to a decision as to the kingdom to which a given organism should be referred, and in many cases the determination is purely arbitrary.

Mr. Clements justly regrets the little attention paid to poultry in England, and the consequent necessity for the importation of large quantities of eggs. At the same time we must remember that the dampness of our climate is a drawback as regards the common fowl, and still more so in case of the turkey.

We are somewhat surprised at finding in this work so little reference to the diseases of cattle, and especially the epidemics that have of late years wrought so much havoc, as well as the prospect of checking these evils, which has been opened out by the researches of M. Pasteur.

The work before us must be pronounced, as a whole, useful and valuable, though we must express the hope that the author, in the very probable case of a new edition, will re-consider the passages to which we have felt it our duty to take exception.

Electro-typing: A Practical Manual, forming a New and Systematic Guide to the Reproduction and Multiplication of Printing Surfaces and Works of Art by the Electro-Deposition of Metals." By J. W. Urquhart, C.E. London: Crosby Lockwood and Co.

The time has altered since the earliest manuals of electro-metallurgy appeared. What was then one novel art has

grown into two distinct branches—electro-plating and electro-typing. The former term as now employed is restricted to the deposition of a thin coat of some more valuable metal upon a metallic article for the purpose of ornament, or of preservation from corrosion. The electrotypist seeks to produce a distinct and separate object, which when complete is removed from the mould upon which it has been deposited.

In the work before us the author enters systematically and thoroughly into every department of the process, in the style of one who combines theory with practice.

At the outset he gives the nomenclature of the art, explaining what is meant by electrolysis, electrodes, ions, the ohm, farad, weber, and volt, and giving an account of the electric circuit, of conductors, insulators, currents, and electromotive forces. The difficulties due to polarisation in the battery and in the depositing cell are touched upon. The author then treats of the decomposition of different solutions, showing how to find the electric equivalent of a metal by dividing the atomic weight by the valency. He then passes to the relation of current to work, the effects of large and small electrodes, and the resistance of the solutions. The second chapter treats of the metals used in electro-typing.

In the third chapter we find an account of the available sources of electricity. Where there is abundance of regular work he gives the preference as regards economy to a dynamo-electric machine, such as those of Gramme, Wilde, or Siemens, the two former of which are here figured.

Thermo-electric batteries, such as that of Clamond, the author considers to be a cleaner and cheaper source of electricity than the galvanic batteries, but they have scarcely received fair play at the hands of the trade. Among galvanic batteries he thinks the Daniell and the carbon-and-zinc bichromate cells decidedly less costly than the Smee. For the measurement of current—a point very generally determined by guess or by rule of thumb—he recommends Sprague's galvanometer. The following chapters are devoted to a very thorough consideration of the solutions, the depositing vessels, the moulding materials, the preparation of the work, the depositing process. We can recommend this treatise not merely to amateurs but to those actually engaged in the trade, many of whom are content to pursue blindly the routine they have once for all learnt without caring to understand the principles of the art. We are convinced that Mr. Urquhart points the way to many improvements of too much value to be overlooked.

Lehrbuch der Organischen Qualitativen Analyse. (Manual of Organic Qualitative Analysis). Part II. By Von Dr. Chr. Th. Barfoed. Kopenhagen: A. F. Höst and Sohn.

In this second part of his manual, Dr. Barfoed continues instructions for the recognition of the saccharine bodies, cane-sugar, grape-sugar, and milk-sugar. He then passes over to the gums, dextrin, arabin, cerasin, bassorin, vegetable mucus, and pectin. It will be at once perceived that not a few organic bodies, occurring in nature and liable to be met with in vegetable mixtures, are here omitted. The author next proceeds to the consideration of the neutral fats. After those which yield glycerin on treatment with alkalies he describes spermaceti and wax, followed by a closer examination of glycerin. In all these cases directions are given for recognising the substance in question when accompanied by bodies which disguise its properties. Thus we find instructions for the detection of neutral fats or free fatty acids in presence of soap; for mixtures of glycerin with sugar and glucose, &c. The resins and gum-resins are described at some length. The author remarks that the detection of the various resins when presented separately is not difficult. In the state of mixed powders it is less easy, and still less so if they have been melted together. In this case little more can be done than to put on record their behaviour in boiling water, their fusibility, their solubility in alcohol, ether, the alkalies, &c. Under the volatile oils we do not find the characteristic reactions of each specified. There are, however, general directions for the examination of these bodies, either alone or when mixed with resins, fats, soaps, gum, sugar, &c. The next section treats of the recognition of ordinary alcohol in various mixtures, *e.g*, with acids, alkalies, volatile oils, &c. We then come to ordinary ether, its compounds, chloroform, and chloral. We regret that methylic alcohol, a compound so abundantly used in the arts, has not been made the subject of a section.

We come now to the albumenoids. Prof. Barfoed describes specially the properties of albumen, casein, fibrin, glutin, hæmoglobin, and gelatin.

So far as the author has gone we consider its teachings sound and trustworthy, but we see no valid reason for the omission of many bodies of considerable importance.

CORRESPONDENCE.

THE SOCIETY OF CHEMICAL INDUSTRY.

To the Editor of the Chemical News.

Sir,—Referring to the formation of the Society of Chemical Industry, an account of which appeared in your last issue (Chemical News, vol. xliii., p. 164, may I suggest through your columns one way in which such a Society may, in my opinion, greatly benefit our chemical industries? viz., by the establishment of a well-organised School of Chemical Technology, wherein students may be thoroughly instructed in the technical details of processes involved in the application of Chemistry to the Arts and Manufactures, and be shown how to bring to bear upon such processes a knowledge of engineering and building, and other constructive details required in arranging Works and constructing apparatus. The chemical education afforded in this country, excellent as it is in such schools as Owens College, laboratories at South Kensington, and elsewhere, does not, as it appears to me, sufficiently deal with truly technical details; and if the new Society—dealing, as I understand it is intended it should deal, with really technical matters—can see its way to the establishment of a really efficient School of Chemical Technology, then it will do work not only of immense benefit to the chemical industries of this country, but of world-wide importance.

Another field of usefulness for such a Society seems to me to be the collection and systematic arrangement of all information of importance to our chemical manufactures, so as to form as complete a library as possible of Chemical Technology.—I am, &c.,

A. Norman Tate.

Analytical Laboratory and School of Technical Chemistry,
7, 8, 9, and 11, Hackin's Hey, Liverpool,
April 12, 1881.

THE SOCIETY OF CHEMICAL INDUSTRY.

To the Editor of the Chemical News.

Sir,—Pray how far is the subdivision of chemical society to be carried? Perhaps as far as Scotch theological society, regarding which, if my memory serve me rightly, the following is told:—In a certain district the various sections had divided and subdivided, and divided again. At last the "true Kirk" was supposed, by its members, to be represented by only two individuals, a man and his wife, "and," said the latter, "I'm no that sure of e'en Jamie."

We have the Institute, the Chemical Society, the Pharmaceutical Society and Conference, the Society of Public

Analysts. To these is now to be added a Society of Chemical Industry.

I believe that much of this division is utterly unnecessary, and very expensive to a body of men not—as a rule—too well off. I cannot conceive why this last Society should not form a section of the Institute, if the Chemical is too purely scientific, the Pharmaceutical too much devoted to pharmacy, and the Public Analysts too much interested in mere analysis. It is difficult enough now to get a decent meeting of the Institute; it will be doubly so if chemists are called upon to attend other meetings.

But if the promoters of this Society wish to include in it some who, though not strictly chemists, yet are interested in chemistry, why should they not endeavour to form a technical section of the Chemical Society, with a night for meeting distinct from the scientific night?—I am, &c.,

F.I.C., F.C.S.

BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—The cause of scientific accuracy is not to be advanced by unjust criticism, though it has been, and will continue to be, advanced by just criticism, however severe.

Your correspondent William Thomson has unintentionally misconstrued the statements made by me in a previous letter (Chemical News, vol. xliii., p. 115). In the first place, he states—"Mr. Staveley says that he distilled a sample of benzol, *and did not allow the temperature to rise above* 97° C., and he obtained 37 per cent distillate." What I did state was—"Wishing to give his (Mr. Thomson's) apparatus a trial, I, by means of a copper water-bath and retort, fitted up a similar apparatus, and placed in the retort 100 c.c. of 30 per cent benzol. . . . After the water in the copper bath had been boiling about one and a half hours 37 per cent distillate was recorded, *whilst the thermometer on the retort had not registered more than* 97° C."

Mr. Thomson also says that "he (Mr. Staveley) says such differences as three-eighths of an inch and one inch on thermometer bulbs do not exist." Whereas my statement was—"The thermometers used in various parts of the country for benzol testing vary but slightly, and in no instance would there be such a difference as one inch and three-eighths of an inch."

On such misconstructions Mr. Thomson bases his arguments. To such an unfair criticism I shall not attempt to reply except to say that the whole of my statements are based on many years' experience in a large benzol refinery.

In conclusion I should be pleased to correspond with "J. D." and "Country Tar Distiller," in whose last letter I am much interested. With a view to making a series of experiments to determine the influence of barometric pressure, &c., on the results of benzol tests, the whole question could then be discussed, say, at an early meeting of the new "Society of Chemical Industry,"—a Society which I believe will do much towards lessening the number of disputes occurring in all branches of chemical industry, by the formation of Boards of Arbitration consisting of chemical "*Specialists*."—I am, &c.,

William W. Staveley.

West Bromwich.

BENZOL TESTING.

To the Editor of the Chemical News.

Sir,—To assist to some extent in eliciting information on this subject, I some weeks ago gave you the result of my experience as to the effect of barometric pressure on the benzols which have passsd through my hands during a number of years. These have been Scotch benzols only; and from what was said by one of your correspondents, whose experience, on the other hand, seemed to refer to English make of benzol, the difference in our results pointed in my mind strongly to a solution of the question both as to English and Scotch, or in fact to any make, whatever the specific gravity might be. In the meantime allow me to confirm what I said as to the effect of barometric pressure on the benzols which have passed through my hands, these being, as I have said, Scotch make, and of a specific gravity of about 866° in the case of 30 per cent. In fact I then rather under than overstated the effect of pressure.

After reading your correspondent's letter referred to, I procured a sample of English make having a specific gravity of 873·6, and tested it for the quantity of distillate at 100° C. with my usual apparatus. It gave 35 per cent, the barometer indicating 29·9; and afterwards, by means of an air-pump attached to the retort, another portion of same sample was tried under a steady pressure of 28·9, and it then gave 39 per cent. From these two experiments it would not be wise to attempt to form rules for testing; but from these and other matters connected with the subject which have come under my observation, I am confident that on that line of investigation will be found a mode of procedure applicable to all makes of 30 per cent and 50 per cent benzols; and to endeavour to bring out of this correspondence a practical result I would suggest that a competent analyst be appointed by the tar distillers interested, who, with information gathered from various testers, should not have much difficulty in giving us a fixed and satisfactory mode of testing which would be applicable to all benzols and under all states of the atmosphere. In the meantime, and until some universal system is adopted, I intend to continue testing as hitherto, and with the same apparatus I have always used, but in all cases will first of all take the specific gravity, and if in the case of 30 per cent it is 866° (our usual sp. gr.) will allow 0·8 per cent for every tenth of mercury above or below 30 inches (this standard I think, however, too high); but if the specific gravity reaches 870°, which it has on one or two occasions, I will then allow only 0·6 per cent, and so on in proportion to the specific gravity.

The points I would like to see determined by an analyst of authority are—the effect of atmospheric pressure in relation to specific gravity (this should be particularly observed, and a table formed for reference), capacity and form of retort, length and diameter of tube of Liebig's condenser, form of tube at outlet, number of drops of distillate per minute, quantity of liquid to be used in testing, diameter of receiving vessel, length of stem and form of bulb of thermometer, and the mode of applying the heat. I may mention that I use an arrangement by means of which the bottom only of the retort is heated.

Referring to a remark made by one of your correspondents, I have repeatedly tested the same sample of 30 per cent benzol under the same conditions of barometric pressure, apparatus, and rate of boiling, and always got an uniform result.—I am, &c.,

J. D.

ESTIMATION OF PHOSPHORUS IN STEEL.

To the Editor of the Chemical News.

Sir,—In your issue of the 1st inst. (Chemical News, vol. xliii., p. 147) there appeared a paper by Mr. J. Oliver Arnold, F.C.S., detailing some experiments on which the author bases a very sweeping condemnation of the method of estimating phosphorus originally described by Eggertz. As it is but too often the case that conclusions against which no protest is made are swallowed whole by the too credulous, I propose to point out certain respects in which Mr. Arnold's results and conclusions are open to curious exception.

To prove the accuracy of the magnesia method Mr. Arnold adopts the astonishing device of adding a weighed amount of magnesium pyrophosphate to the steel, and then proceeding as before. Without knowing at what

stage he added the pyrophosphate, it is not possible to estimate the chances of its undergoing conversion to orthophosphate, but for the same reason the value of the r sults is very slight.

Without going in detail into Mr. Arnold's results, almost all of which, however, are open to exception, I may point out that the low results he obtained by the molybdate process are clearly due to inattention to several conditions which are well known to be important in the attainment of success. Thus—

1. Mr. Arnold used "a moderate excess" of the molybdate solution, whereas every tyro knows that the presence of a very *large* excess is important, if not essential.

2. Mr. Arnold manipulated in presence of ferric chloride and some free hydrochloric acid, whereas careful operators get rid of all chlorides by evaporating several times to a low bulk with nitric acid.

3. Mr. Arnold allowed only "an hour or two" for the formation of the yellow precipitate, instead of the much longer time commonly regarded as requisite in the absence of a "hastener."

It appears, therefore, that Mr. Arnold neglected three of the most important conditions of success, and this in a series of experiments intended to test the value of the method.

Mr. Arnold proposes to do what so many chemists whose experience of phosphoric acid determinations is limited to agricultural products have thought possible,—namely, to precipitate the phosphorus by molybdate, redissolve in ammonia, and precipitate by magnesia mixture. Magnesium pyrophosphate contains 27·93 per cent of phosphorus, whereas the molybdate precipitate contains only 1·63 per cent. Mr. Arnold, in his six test experiments by the magnesia process, obtained a mean weight of 13·9 m.grms. of pyrophosphate. If he had weighed the corresponding amount of phosphorus as the molybdate precipitate he would have obtained 234·9 m.grms. Conversely, by his suggested modified plans, he would redissolve 234·9 m.grms. of yellow precipitate in order to convert it into 13·9 m.grms. of magnesium pyrophosphate! And this is done for the purpose of getting a more accurate result! If it be admitted, which it is now almost universally, that the composition of the yellow precipitate is practically constant if it be produced under the same general conditions, what possible advantage can there be in its re-solution? Of course I am here referring to determinations of phosphorus in steel, for I doubt whether the composition of the precipitate is so constant as to render the weighing safe when large percentages of phosphorus are to be determined. Suppose that the amount of yellow precipitate which *ought* to be obtained from 5 grms. of a given steel is 200 m.grms., but that, from various causes, the weights actually obtained in two experiments were 195 and 205 m.grms., then the true and observed percentages of phosphorus will be as follows:—

	True.	Experiment.	
		I.	II.
Phosphorus per cent ..	0·0652	0·0636	0·0668

In other words, a variation of 5 per cent in the weight of the molybdate precipitate produces a perfectly insignificant effect on the proportion of phosphorus reported, whereas the small proportional variation in the weight of the magnesium pyrophosphate would be much more serious.

Though not admitting the accuracy of most of Mr. Arnold's conclusions, I think his contribution fully justifies him in his assertion that many estimations of phosphorus carried out in the laboratories of iron and steel works are utterly unreliable.

As arguments do not depend for their cogency on the identity of their employer, I prefer to sign myself,—Yours, &c.,

PHOSPHORUS.

April 11, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Moniteur Scientifique, Quesneville.
November, 1880.

Heat of Combustion and of the Formation of Organic Compounds, according to the Rational Formulæ.—G. Quesneville.—Setting out with the simple hypothesis that to remove a radicle from a centre of attraction, it is necessary to effect a certain work measured by a number of great calories proportional to the molecular weight of such radicle, the author has been able to calculate the heats of combustion and of formation for all organic compounds whose chemical syntheses have enabled their rational formulæ to be detected. The heat of formation is proportional to the molecular weight: $Q=pT$. If the compound is formed (as in ethylene) of simple radicles, C, H, and an atom of carbon plays the part of the centre of attraction, we have $Q=(C+4H).T$, the value of Q being given by the second relation $Q=\Delta$, whence we infer $T=\Delta:(C+4H)$. For ethylene we have $\Delta=-15{\cdot}4$ and $C+4H=16$, whence $T=-1$ approximately, which if substituted in the fundamental equation, gives the heat of combustion 342, verified by experiment 341·4. In these, expression T is the work, estimated in calories corresponding to the displacement of the unity of weight. Tp is the work corresponding to the displacement of a radicle of the molecular weight p. The author represents by Δ the heat of the formation of a compound from its elements, *i.e.*, the difference between the sum total of the heats of combustion of the elements and the heat of the combustion of the compound, identical products being formed. Such difference should represent in calories the sum of all the work, which in the case of marsh-gas is obtained by grouping the elements C, H, H, H. On calculating such works separately we obtain in calories a number Q, which must be, if the hypothesis is correct, precisely equal to the difference Δ.

Academy of Medicine.—At the meeting of the 12th October, during the adjourned discussion on the "cholera of poultry," the animosity between M. Pasteur and M. Jules Guérin reached such a height that they had to be forcibly kept asunder. What renders this scene the more deplorable is that M. Guérin is 84 years of age and M. Pasteur is paralysed on one side of his body!

The Odours of Paris.—A long report on the sanitary condition of Paris and the means proposed for its improvement. It is remarked that a proposal has been made to extend irrigation works to Saint Germain and other suburban communes. But sufficient attention has not been given to the extent of irrigation ground needful to utilise all the water. In fact 400,000 cubic metres daily represent 4600 litres per second, which in the south of France is enough to irrigate 4600 hectares; and there irrigation is only applied from April 1 to September 30. If sewage is to be poured upon the soil all the year double, perhaps triple, or quadruple, the surface will be required if the soil is not to be saturated and rendered unfit for crops. The author further asks, What is to be done in time of heavy rains and snows, when the flow of sewage is greatest and the soil least able to receive it?

Process for Rendering Tissues and Wood Uninflammable.—A. Martin.—Taken from the *Bulletin de la Société d'Encouragement.*

Determination of Nitrogen by Means of Soda-lime. MM. Gassend and Quantin.—The authors find sources of error in the weight of the sample taken for analysis and its percentage of nitrogen, in the length of the tube and the duration of the combustion, these two causes acting in the same direction. If the escape of bubbles is too

slow, or if the tube is too long a greater or less proportion of the ammonia may be decomposed into nitrogen and hydrogen. The quantity of matter employed ought to be such that not more than half the standard acid may be saturated by the ammonia evolved. The combustion-tube should not exceed 40 centimetres in length, and the plug of asbestos should be from 3 to 4 centimetres.

Justus Liebig's Annalen der Chemie,
Heft 2, 1880.

Researches on the Magnitudes of the Affinities of Carbon.—This memoir consists of two sections, the first of which, by A. Geuther, treats on the conversion of chloro-carbonic acid into formic acid. The author remarks that the affinities of carbon may be resolved into two groups, which he names, respectively, carbonic oxide affinities and carbonic acid affinities. He raises the questions whether the affinities in each of these groups are equal or unequal among themselves, and whether those of each are equal or unequal to those of the other? His experiments show that chloro-carbonic acid can be converted into ordinary formic acid by the direct substitution of hydrogen for chlorine. The second part of the memoir by Dr. Bruno Röse on "New Carbonic Ethers," gives a reply to the first of these questions.

Chemisches Central-blatt.
No. 31, 1880.

Guthrie's Cryohydrates.—H. Offer.—The author thinks that the balance of probability is in favour of Pfaundler's view, viz., that these bodies are mechanical mixtures of salt and ice.

Propargylic Acid as a Decomposition-Product of Ethylen-dicarbonic Acid.—E. Bandrowsky.—Propargylic acid is a colourless liquid which smells of acetic acid, and assumes a dark colour on exposure to the air. It boils at 145° and congeals at −6°.

Journal für Praktische Chemie.
Parts 5 and 6, 1880.

The Cyanamide Compounds of Succinic Acid.—Dr. H. Möller.—Succinic acid forms with cyanamide three compounds corresponding to those formed with ammonia, succincyaminic acid, succincyanimide, and succincyamide. Succinic anhydride with potassium cyamide either in alcoholic or watery solution forms potassium succincyaminate. Succincyaminic acid, like succinamic acid, is easily decomposed. It is a strong bibasic acid, and forms two series of salts, among which the author describes those of potassium, barium, calcium, and silver. By the action of succinic acid chloride upon cyanamide in absolute ether, free from alcohol and water, there is formed succincyanimide along with cyanamide hydrochlorate. Succincyanimide, like succinimide, is decomposed by water into succincyaminic acid, and by alcohol into ether-succincyaminic acid. Sodium cyamide and ethyl oxide succinate in alcohol yield succincyamide sodium. Sodium cyamide and succinic acid chloride yield sodium chloride and sodium succincyamide. Succincyanimide melted with cyanamide yields succincyamide. This last-mentioned body is an acid and behaves more like cyanamide than succinamide.

Combustion-Heat of Organic Compounds (Continued from vol. 22, 1).—Dr. C. v. Rechenberg.—The author examines here the application of the heat of combustion to the explanation of chemical processes, and the liberation of heat during the hydrolytic transformation of the carbohydrates, which, like the transformation of cellulose, inuline, and metarabic acid into fermentible sugar, is always attended with the development of heat, and concludes that every fermentation is attended by this phenomenon. He points out that in certain isomeric groups the heat of combustion decreases as the melting-point rises, whilst the heat of formation increases, but the differences are so small as to fall within the limit of experimental error.

Determinations of Chemical Affinities.—Dr. W. Ostwald.—In this paper, which does not admit of useful abridgment, the author points out the hazard of employing the speed of reactions for the determination of affinity.

Cyanæthine and its New Basic Derivatives.—E. von Meyer.—Not adapted for abstraction.

Action of Hydrochloric Acid upon Organic Amides—L. Schulerud.—Amido-benzoic acid, heated in a current of dry hydrochloric acid, yields water and ammonia, whilst a solid matter remains in the retort, probably a condensation-product.

MISCELLANEOUS.

Chemical Labels.—Messrs. Woolley, Sons, and Co., of Manchester, have sent us some sheets of chemical labels which are likely to be useful in Laboratories under the "Science and Art Department." Some, printed on white paper, every student is required to have on his working bench; while others, on red paper, are for general use in the Laboratory. It has been found that general reagents find their way, accidentally or through carelessness, amongst the students' reagents, thus causing loss of time to others who require them in discovering where they are. By printing the general reagents on red paper the student will immediately see, should he have a red label amongst his own reagents, that it is in its wrong place. The printing is bold and legible, the formula of each reagent is given, and the labels are gummed at the back.

MEETINGS FOR THE WEEK

MONDAY, 25th.—Medical, 8.30.
—— Philosophical Club (Anniversary), 6.30.
TUESDAY, 26th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.
WEDNESDAY, 27th.—Society of Arts, 8. "Five Years' Practical Experience of the Working of the Trade Marks' Registration Acts," Edmund Johnson.
—— London Institution (Anniversary), 12 noon.
—— Geological, 8.
THURSDAY, 28th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Magnetism," Professor Tyndall.
—— Society of Arts, 8. "Impurities in Water, and their Influence upon its Domestic Utility," G. Stillingfleet Johnson, F.C.S.
FRIDAY, 29th.—Royal Institution, 8. "Language and Literature of the Scottish Highlands," Prof. Blackie, 9.
—— Society of Arts, 8. "The Building Arts of India," General Maclagan, R.E.
SATURDAY, 30th.—Royal Institution, 3. "Scotland's Part in English Literature," Prof. Morley.

TO CORRESPONDENTS.

Carbide of Iron.—Wanted the address of a maker of commercia carbide of iron for filtering purposes.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1118.

NOTES ON THE OXIDES OF MANGANESE.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon, F.C.S.,
Assistant Master at Highgate School.

In a paper which appeared in the *Journal of the Chemical Society* for 1879 (p. 659), "On the Action of Hydrochloric Acid on Manganese Dioxide," I alluded to certain experiments which proved that some oxides of manganese, when heated in air to a temperature of 200° or even 100° C., experienced either a loss or gain of oxygen according to the amount of dioxide contained in them. It was intended that the interesting subject with which these experiments dealt should be thoroughly investigated and the results laid before the Chemical Society, but after about three week's further work (ending July 10th, 1879) the subject was found to be so much more complicated than had at first been anticipated, that time and means for its investigation were found wanting.

The experiments, such as they are, which will be described in the present paper, must be regarded simply as preliminary experiments—and, consequently, of a somewhat rough nature; indeed, they would not now be published did they not agree more or less with some results published by Wright and Menke in January, 1880, and others of a still more recent date published by Veley. They, however, contain also a few facts which have not hitherto been ascertained by these or other authors, which, if not thoroughly investigated here, may at any rate offer useful suggestions to those who intend to pursue the investigation of the manganese oxides any further.

§ I. *Oxides used.*

Two classes of manganese oxides were used in these experiments. (1) Impure, procured from Messrs. Hopkin and Williams, and prepared by means of sodium hypochlorite; (2) pure, obtained by the decomposition of an acid solution of manganese sesquichloride by an excess of water. The former of these (commercially known as "pure" oxides) contained a considerable amount of sodium and calcium salts, the calcium being derived from the undistilled water used in washing them,* but they contain no trace of iron or other heavy metal. From 65·53 to 32·07 per cent of the manganese contained in them was present in the state of dioxide (the rest being considered present as monoxide†). In order to prepare the second class of oxides, some of the impure samples were dissolved in the least possible amount of hydrochloric acid, the solution filtered, and poured into a large volume of a distilled water sufficient to effect the perfect decomposition of the manganese sesquichloride present, from 1 to 5 litres of water being used for each grm. of oxide thus precipitated. These oxides are absolutely pure, and contain no trace whatever of any foreign substances. About 1 grm. of each sample was dissolved in hydrochloric acid, ammonia added, and the manganese precipitated with hydrogen sulphide. On filtration and evaporation (all the operations being performed in platinum vessels), with the addition of a few drops of sulphuric acid, and subsequent ignition, there was in no case the slightest trace of residue obtained which was either weighable on a delicate balance or visible with the help of a strong magnifying lens. Hence in this way all the alkaline and earthy impurities present in the original oxide taken (amounting to as much as 7 or 8 per cent when calculated as hydrates), are entirely eliminated, and a perfectly pure oxide is obtained; this method appearing to be one of the few by which a pure highly oxidised *hydrated* oxide has been obtained.* These results are in opposition to those obtained by Wright and Menke (*Jour. Chem. Soc.*, 1880, p. 33), who found a very considerable amount of impurity in oxides prepared by this process. It is true that the original oxide with which Wright and Menke obtained their solution of the sesquichloride contained potassium, whereas mine contained calcium and sodium; this fact, however, can scarcely account for the difference in the results obtained, for they state that in the case of calcium, the tendency of manganese dioxide to carry down foreign metals in combination appears to be superior to its power of uniting similarly with potassium (*ibid.*, p. 23). These pure oxides used in the following experiments contained from 83·13 to 83·2 per cent of the total manganese present in the state of dioxide.

§ II. *Method of Experimenting.*

In conducting these experiments, a weighed quantity of the oxide was placed in a watch-glass, amd heated in an ordinary copper air-bath till its weight remained constant; it was then heated again in the bath for about half-an-hour, and then while still hot thrown into an acidulated solution of potassium iodide, the liberated iodide being determined in the manner described and fully investigated in a previous paper (*Jour. Chem. Soc.*, 1880, p. 128). It could hardly have been expected that the temperatures recorded by a thermometer placed in a bath such as that used would have recorded with any accuracy the temperatures at which the oxides in the bath were really heated. Some experiments, however, which have been performed more lately, using a vapour-bath, and which will be specially noticed below, show that the temperatures here recorded cannot, in some cases at any rate, be very erroneous. In order to obtain concordant results it was found necessary always to place the watch-glass in the same position in the bath.

§ III. *Experiments with Impure Oxides.*

1. *Oxide No.* 1.—This was a sample of the so-called "pure manganese dioxide" procured from Messrs. Hopkin and Williams. A determination of the impurities present gave the following results:—

$Ca(OH)_2$	3·44 per cent
NaOH	4·16 ,,
Total	7·60 ,,

After deducting these impurities the composition of the oxide was† :—

MnO_2	55·396 per cent
MnO	24·910 ,,
H_2O	19·694 ,,

Whence we find the total manganese present to be 54·298 per cent, and—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{65{\cdot}53 \text{ per cent}}{34{\cdot}47 \text{ per cent}} = 1{\cdot}901.$$

The results obtained with this oxide are given at length in Table I. They show that even at the lowest temperature employed—namely, 100° C.—this oxide gains a very appreciable amount of oxygen corresponding to an increase

* Messrs. Hopkin and Williams now prepare their "pure manganese dioxide" by a different process, by which they obtain a purer, and at the same time a richer, substance.

† For the sake of simplicity all oxides will in this paper be considered as mixtures and compounds of the dioxide and protoxide.

* A pure non-hydrated oxide may be obtained by the ignition of the nitrate, but Wright and Menke failed to obtain a pure hydrated oxide either by the action of nitric acid, sulphuric acid, sulphur dioxide, alcohol or glycerin, or of manganese sulphate on potassium permanganate; or by the oxidation of manganous hydrate, which had been prepared by potash, in air; or by the addition of bromine to manganese chloride in the presence of potassium acetate (*loc. sup. cit.*) Veley obtained a pure hydrated oxide by passing chlorine into a solution of manganese acetate.

† These oxides were analysed in the manner described in a previous paper (*Chem. Soc. Jour.*, 1880, p. 659.)

of 1·37 per cent on the dioxide present before heating: this gain increases rapidly as the temperature rises, exceeding 10 per cent at 200° C. The results, when represented diagrammatically, form a curve of considerable uniformity.

Inasmuch as the operation of weighing a somewhat hygroscopic substance in a watch-glass does not admit of great accuracy, it was thought possible that a small gain of oxygen might take place by prolonged heating, even after any change in weight had ceased to be observed, the last eight experiments given in the table were peformed, and they show in this case that when the heating is prolonged beyond half an hour no further alteration takes place. In the case of all the other oxides investigated, from half-an-hour to one hour was found sufficient to complete whatever change they experienced, although, for the sake of greater security, the heating was in most experiments continued for two or three hours.

A few experiments performed with this oxide seemed to show that after it had been heated at the above-mentioned temperatures, and been made thus to absorb a considerable amount of oxygen, it did not evolve this oxygen on being exposed to air at ordinary temperatures. Similary, other oxides which lost oxygen on being heated remained unchanged at lower temperatures after that heating.

TABLE I.

Experiments on the Oxide No. 1.

Conditions of Expt.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Increase in the MnO_2 present. P.c. gain.
Before heating—			
1.	55·449		
2.	55·480		
3.	55·360		
4.	55·267		
5.	55·387	55·396	
6.	55·432		
7.	55·478		
8.	55·306		
After heating—			
9. At 100°	56·233		
10.	56·172		
11.	55·967	56·152	
12.	56·182		1·37
13.	56·308		
14.	56·150		
15. At 168° C. ..	58·874		6·28
16. At 190° C. ..	60·191		8·656
17. At 200° C. ..	60·999		
18.	61·071		
19.	61·514		
20.	60·815	61·075	10·25
21.	61·026		
22.	61·128		
23.	60·972		
24. At 202° C. ..	61·534		11·08
25. At 203° C. ..	61·678	61·693	11·35
26.	61·708		
27. At 100° for ½ hr.	56·152	56·280	
28.	56·408		
29. At 100° for 2 hrs.	55·967	56·012	
30.	56·057		
31. At 100° for 4 hrs.	56·151	56·304	56·150 1·365
32.	56·457		
33. At 100° for 6 hrs.	56·116	56·004	
34.	56·992		

2. *Oxide No. 2.*—This oxide, like the previous one, was obtained from Messrs. Hopkin and Williams. It was, however, less rich in oxygen, and, deducting the 7 per cent of impurities which were present, its composition was found to be—

MnO_2	45·993 per cent
MnO	50·171 ,,
H_2O	3·936 ,,

And hence it contained 67·919 per cent of manganese, present in the following state of oxidation :—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as } MnO_2} = \frac{42{\cdot}79 \text{ per cent}}{57{\cdot}21 \text{ per cent}} = 0{\cdot}748.$$

From the fact that this oxide contains considerably less oxygen than No. 1, it might have been anticipated that on being heated it would have taken up more oxygen than No. 1 did. So far, however, was this from being the case, that it was found not only to absorb no oxygen at all, but even to lose an appreciable amount at 100° C. and higher temperatures, as will be seen in Table II., where the experiments on this oxide are recorded. It will also be observed that the amount of change in composition is not increased by an increase of temperature to nearly such a great extent as in the case of No. I.

TABLE II.

Experiments on the Oxide No. 2.

Before heating—			
35.	45·991	45·993	
36.	45·996		
After heating—			
37. At 100° C. ..	45·626	45·687	0·665 p.c. loss
38.	45·747		
39. At 183° C. ..	45·494	45·526	1·015 p.c. loss
40.	45·526		

3. *Oxide No. 3.*—This oxide was prepared by the ignition of some of the first-mentioned specimen. In composition it approximated to Mn_3O_4, as is seen from the following analysis (the impurities present being deducted) :—

MnO_2	37·467 per cent
MnO	61·875 ,,
H_2O	0·650 ,,

Whence the total manganese present was 71·464 per cent, and—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as } MnO} = \frac{33{\cdot}07 \text{ per cent}}{66{\cdot}93 \text{ per cent}} = 0{\cdot}494$$

That this oxide should contain rather less oxygen than is required by the formula Mn_3O_4 is explained by the fact that the ignition was performed in a platinum dish, in which case the unburnt gases from the flame permeate the metal and reduce some of the oxide to protoxide, a phenomenon which was observed about the same time by Wright.

The very concordant results which were obtained in this case are given in Table III., and they show that this oxide experienced no alteration whatever in composition on being heated either at 100° or at 180° C., although, considering its poorness in oxygen as compared with No. 1, it might have been expected to have absorbed a large amount of that gas.

TABLE III.

Experiments on the Oxide No. 3.

Before heating—			
41.	37·463	37·467	
42.	37·379		
43.	37·559		
After heating –			
44. At 100° C. ..	37·476	37·514	Not appreciably altered.
45. At 180° C. ..	37·507		
46.	37·559		

(To be continued.)

The Fermentation of Urea.—C. Richet.—Solutions of urea placed in contact with portions of muscular tissue quickly undergo the ammoniacal fermentation.—*Comptes Rendus.*

ON THE HOT SPRING AT NATMOO NEAR MAULMAIN, BRITISH BURMAH.

By R. ROMANIS, D.Sc., Chemical Examiner to Government.

The neighbourhood of Maulmain is remarkable for the number of hot springs. The soil is alluvial with ridges of laterite and carboniferous lime-stone. The nearest of these springs is at Natmoo, in the island of Beloogyoony, which lies between Maulmain and the sea. We found the spring in a thicket of bushes in the middle of rice fields, about two miles from the hills and one from the river bank. It is a circular pool about 12 feet in diameter and 4 feet deep. The edges were incrusted with a white mud which proved to be carbonate of lime. A gas, probably carbonic acid, bubbled up through the water, the temperature of which was 130° F. All around the pool and the stream which flowed from it, lay numbers of a small land shell, a species of Conovulus.

A slab of teak-wood had been erected near. On one side was an inscription in English, stating that the spring had been discovered in 1866, when Col. D. Brown was commissioner of Tenasserim. On the other side was an inscription in Taline saying that the Beloos (ogres) came every night to drink their.

About a quart of the water was brought away and analysed with the following results:—

$NaCl$	10·446
KCl	0·344
$CaCl_2$	2·218
$MgCl_2$	0·855
SO_3	0·109
Fe_2O_3	0·002
$CaCO_3$	0·175
	14·169 grms. per litre.
Residue on evaporation	14·07 " "
Chlorine per litre	8·0 " "

A SULPHURETTED HYDROGEN APPARATUS.*

By PETER HART.

When hydric sulphide is only occasionally required, and then in small quantities, an apparatus which so furnishes it is useful, especially when it can be used repeatedly without washing out or replenishing. The one I have contrived seems to me to fulfil these conditions. There have been many invented, but they mostly require either many joints or especially formed pieces of glass. This one can be made by any one possessing only very small skill in fitting up apparatus. It consists of two test-tubes, the larger of *one* inch internal diameter, the other of such smaller diameter as to slide easily without friction into the larger. This smaller tube is by means of the blowpipe perforated at the bottom with a quarter-inch hole and is also provided with a rubber stopper and a gas leading tube bent twice at right angles. The larger tube has a piece of rubber tube two inches in length, and of rather smaller diameter than itself, pushed over its mouth, one inch on the tube and one inch projecting. This completes the apparatus. To work it fill the larger tube from one-third to one-half full of a mixture of sulphuric acid and water—one part acid, three parts of water. Drop a lump of iron sulphide into the smaller tube, insert the stopper with leading pipe firmly into this, and thrust its lower perforated end through the rubber mouth of the larger tube, pushing it down until it reaches the acid, and allowing sufficient of this to enter the perforation to cover the sulphide iron. Gas immediately commences to be evolved and can be bubbled through the solution to be examined. When sufficient has been obtained, raise the upper tube until the lower end is out of the acid, the remains of which at once drain away from the sulphide and all action ceases, or practically so. It is only necesaary to hang up the apparatus until again needed, when, by heating the end of the lower tube containing the acid over a Bunsen burner, and pushing down the upper, it commences full action again. This can be repeated until the acid becomes saturated, or so much so as to require replenishing.

Of course it need not be limited to the dimensions I have named. A much larger upper tube might be employed, which, combined with a suitably sized lower bottle would furnish gas enough for a quantitative analysis. By occasionally sinking the upper tube deeper into the acid the stream may be fairly regulated, sufficiently so at all events for ordinary work.

* A Paper read before the Manchester Literary and Philosophical Society, March 8, 1881.

ON THE

CONNECTION OF THE MOLECULAR PROPERTIES OF INORGANIC COMPOUNDS WITH THEIR ACTION UPON THE LIVING ANIMAL ORGANISM.

By JAMES BLAKE, M.D., F.R.C.S.

During my prolonged researches on the phenomena elicited by the direct introduction of inorganic matter into the circulation of living animals, I have arrived at results which, as I believe, open a new path to the solution of certain riddles of molecular chemistry. The researches were begun with the intention of applying these simpler and better known substances for the analysis of physiological facts, but in the course of my experiments it became clear that living matter might serve as a means for giving a clue to the molecular properties of inorganic matter. In a discourse delivered in 1839 before the Academy of Sciences of Paris, I showed that when solutions of different salts are introduced into the blood of living animals the physiological action depends on the electro-positive component of the salt, and little upon the acid with which it is combined. A communication which I read at a meeting of the Royal Society in June, 1841, proved that the action of inorganic bodies introduced directly into the blood of living animals depends on their isomorphous relations; and in a memoir communicated to the California Academy of Sciences in 1873, I showed that among the compounds of the metallic bodies, strictly speaking, the physiological efficacy of substances belonging to one and the same isomorphous group was proportionate to their atomic weight; the greater the atomic weight the more intense the physiological action. This is not the place to enter closely into the physiological action of the bodies employed in these experiments. They included salts in 41 elements, and their action was tested upon horses, dogs, cats, rabbits, geese, and hens with identical results. Aqueous solutions of the different salts were injected into the blood-vessels of the living animals. Among those of the monatomic metals were salts of lithium, sodium, rubidium, thallium, calcium, and silver. They all agree exactly in their physiological action. The fatal quantity of lithium sulphate for a rabbit is 1 grm. per kilo. of the animal's weight; whilst of silver nitrate, 0·06 grm. was fatal. Among the diatomic metals tried were salts of magnesium, iron, manganese, cobalt, nickel, copper, zinc, and cadmium, as also calcium, strontium, and barium. In the salts of the magnesium series, the analogy of physiological action is very manifest, and their activity is enhanced with the increase of the atomic weight, rising from 0·97 grm. per kilo. for magnesium sulphate to 0·08 grm. for cadmium sulphate. The salts of calcium, strontium, and barium form likewise a group in which the increasing physiological action is very distinct, being 0·47 per kilo. in calcium chloride and 0·043 grm. per kilo. for

barium chloride. The physiological reactions of the lead salts resemble those of the barium group, though agreeing in certain reactions with the salts of silver. (Similar transition-reactions were observed in the salts of magnesium, calcium, silver, and gold.)

Among the tetratomic metals, the salts of thorium, palladium, platinum, osmium, and gold were examined. All showed great similarity in their physiological action, ranging from 0·029 grm. per kilo. in thorium sulphate to 0·003 grm. per kilo. in gold chloride. The decided and characteristic effect of this class of substances upon the action of the heart was shown in the most surprising manner by the compounds of gold, which even in the minute dose of 0·003 grm. per kilo. kept up the action of the heart for several hours after death, though the temperature of the body had sunk 13° below the normal heat of the animal.

Among the hexatomic metals, the salts of glucinum, aluminium, and iron (ferricum) agree perfectly in their physiological reactions. The fatal dose per kilo. ranges from 0·023 in glucinum, 0·007 for aluminium, and 0·004 grm. in ferricum, all in the state of sulphates. The physiological action of glucinum confirms the view that glucinum is a hexatomic metal.

Among the rarer earths, experiments were tried with ytterbium, cerium, didymium, lanthanum, and erbium. There was found a marked difference between the cerous and ceric salts as in those of iron. The difference is, however, less, being 1 : 3 in cerium and 1 : 28 in iron. Among the non-metallic elements, compounds of chlorine, bromine, iodine, phosphorus, arsenic, antimony, sulphur, and selenium were examined. Chlorine, bromine, and iodine agree closely in their physiological reaction, but instead of an increase there is here a decrease in intensity. Phosphorus, arsenic, and antimony do not induce any immediately perceptible physiological reaction. Arsenious acid, injected in the proportion of 0·560 grm. per kilo., checks the pulmonary circulation. Sulphur and selenium are similar in their action, the latter being the more powerful. The only exceptions to the rule, that isomorphous substances act in an analogous manner, are the salts of potassium and ammonium. The latter produce results resembling those of certain nitrogenous alkaloids. If the carbon compounds exhibit similar phenomena in their manner of action upon the living animal body, researches concerning molecular relations will be greatly facilitated. Dujardin has already demonstrated in this direction, that in alcohols of one and the same series the intensity of the physiological action is directly as the atomic weight.—*Berichte der Deutschen, Chem. Gesellschaft.*

ON THE

STRENGTH OF SOLUTIONS OF SULPHUR IN CARBON DISULPHIDE, AND ON ITS APPLICATION TO THE ANALYSIS OF SULPHUR ORES.

By H. MACAGNO.

THE specific gravities of several solutions of sulphur in carbon disulphide, obtained at 15° C. with as much accuracy as possible by the method of the specific gravity bottle, give me the means of drawing on a paper ruled into squares the line representing the solubility of sulphur. This line remains perfectly straight from 1·271 to 1·354 sp. gr. at 15°; from 1·354 to 1·390 it becomes scarcely curved towards the edge on which the weights of sulphur are marked. The same happens at various temperatures from 15° to 25°. The curves result symmetrically arranged, and their curvature becomes more and more remarkable with the growth of temperature. For, I think, one must never exceed 25° if accuracy in results is requisite.

By the method of graphical interpolation, the following table has been calculated. It shows the quantity of sulphur in 100 parts by weight of carbon disulphide:—

15° C. Sp. gr.	100 parts of Carbon Disulph. Dissolve—	15° C. Sp. gr.	100 parts of Carbon Disulph. Dissolve—
1·271	0	1·332	14·7
2	0·2	3	15·0
3	0·4	4	15·2
4	0·6	5	15·4
5	0·9	6	15·6
6	1·2	7	15·9
7	1·4	8	16·1
8	1·6	9	16·4
9	1·9	1·340	16·6
1·280	2·1	1	16·9
1	2·4	2	17·1
2	2·6	3	17·4
3	2 9	4	17 6
4	3·1	5	17·9
5	3·4	6	18·1
6	3·6	7	18·4
7	3·9	8	18·6
8	4·1	9	18·9
9	4·4	1·350	19·0
1·290	4·6	1	19·3
1	4·8	2	19·6
2	5·0	3	19·9
3	5·3	4	20·1
4	5 6	5	20·4
5	5·8	6	20·6
6	6·0	7	21·0
7	6·3	8	21·2
8	6·5	9	21·5
9	6·7	1·360	21·8
1·300	7·0	1	22·1
1	7·2	2	22·3
2	7·5	3	22·7
3	7·8	4	23·0
4	8·0	5	23·2
5	8·2	6	23·6
6	8·5	7	24·0
7	8·7	8	24·3
8	8·9	9	24·8
9	9·2	1·370	25·1
1·310	9·4	1	25·6
1	9·7	2	26·0
2	9·9	3	26 5
3	10·2	4	26·9
4	10·4	5	27 4
5	10·6	6	28·1
6	10·9	7	28·5
7	11·1	8	29·0
8	11·3	9	29·7
9	11·6	1·380	30·2
1·320	11·8	1	30·8
1	12·1	2	31·4
2	12·3	3	31·9
3	12·6	4	32·6
4	12·8	5	33·2
5	13·1	6	33·8
6	13·3	7	34·5
7	13·5	8	35·2
8	13·8	9	36·1
9	14·0	1·390	36 7
1·330	14·2	1	37·2
1	14·5		(saturated).

So far as I can discover, no process has yet been proposed for quantitative analysis of sulphur ores, in order to rapidly estimate sulphur with so much accuracy as in industrial purposes can be necessary. The method consisting in burning the ore, and commonly used, gives no reliable results, because organic matters easily decompose the calcium sulphate always present, the water of this salt is lost, and calcium sulphide is produced.

The table, as above, supplies a good and rapid process to within a per cent at least of sulphur in ores.

We must know :—

P = the weight of carbon disulphide taken.

M = the weight of ore mixed with it.

A = the figure resulting from the table, in order to see specific gravity of the solution of sulphur in carbon disulphide at 15° temp.

Then, the per cent x of sulphur in ore will be known by :—

$$x = \frac{AP}{M}$$

In the case of temperatures between 15° to 25°, as it generally may occur, the sp. gr. observed may be reduced to its amount at 15° by means of the following formula, provided it be less than 1·352 :—

$$S = s + 0{\cdot}0014\ (t - 15°),$$

where S = sp. gr. at 15° (that must be $< 1{\cdot}352$).

s = sp. gr. observed, at t of temperature.

Agricultural Station of Palermo, Italy,
March, 1881.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday April 21st, 1881.

Dr. Debus in the Chair.

The following certificates were read for the first time:—A. B. Avarne, A. W. Duncan, T. King Rogers, J. Schwartz, P. Trigger, G. Tate. It was announced that a ballot for the election of Fellows would take place at the next meeting (May 5).

The following papers were read:—

"*On the Distillation of Mixtures of Carbon Disulphide and Carbon Tetrachloride*," by F. D. Brown. These experiments were carried out with the same method as that employed by the author in some similar experiments made about 18 months ago, with carbon disulphide and benzene. An improvement has been made in the still, which, in the present research was of copper, shaped like an ordinary tin can; the upper portion is covered with a copper jacket closed at the top; it has a sloping bottom, at the lowest portion of which is inserted a tube leading to the condenser. The vapour which rises from the boiling liquid is thus not subjected to the cooling action of the air in the neck of a flask, but after rising from the inner vessel descends through the copper jacket and thence through the tube to the condenser. Any liquid which may condense therefore runs into the condenser and not back to the still. The liquids were purified with the utmost care. The composition of the distillates was found, by a careful determination of specific gravities. The objects of the research were:—(1.) To find the boiling-point of every possible mixture of the two liquids, and (2.) the composition of the vapour evolved by any mixture when boiling. Tables and curves accompany the paper. The first set of experiments was made at the ordinary atmospheric pressure. Another set was carried out at a pressure of 434·8 m.m. The author was rather astonished to find that the curves at the two pressures coincided, and that, therefore, "when a mixture of two liquids is boiled, the composition of the vapour evolved is independent of the pressure under which ebullition takes place. This important conclusion the author hopes to confirm by experiments with other liquids. In conclusion, the author discusses the various theories of fractional distillation proposed by Wanklyn, Berthelot, and T. E. Thorpe: he shews that none of the formulæ proposed by these investigators agrees with the results contained in the present paper, and it appears that the general expression for the ratio of the weights x^1, x^2, of the two vapours given off is

$$\frac{x^1}{x^2} = \frac{W_1}{W_2} C$$

where W_1 and W_2 are the relative weights in the mixture and C is a constant (3·5) which replaces the varying ratio of the vapour tensions. The author suggests that the ordinary vapour tensions, which hold good when a vapour is diffused in a vacuum do not hold good when that vapour is diffused in a space containing another gas. He promises further research on this point. He shews that the results obtained by Thorpe, Berthelot, &c., agree with those obtained in the distillation of two substances which do not mix, and suggests that this non-mixing might be determined by the presence of traces of water.

Prof. Hartley then read a paper, "*On the Estimation of Hydric Peroxide by means of Potassic Permanganate*," by W. E. Adeney. The author undertook this investigation in consequence of some statements published by C. T. Kingzett (as to the error which might be caused by using an acid solution of permanganate), which threw some doubt on some results obtained by Prof. Hartley by the above method. As a result of the investigation, it appears that although the numbers previously obtained by Prof. Hartley have to be modified, the conclusions which he drew from these numbers are not affected.

"*On the Oxidation of Sulphurous Acid*," by H. B. Dixon. When sulphur dioxide mixed with a large excess of air is passed over a moist surface, especially if an alkali be present, much sulphate is produced. There is no doubt, moreover, that dry SO_2 and dry O at ordinary temperatures, have no action on each other, but the question still remains open as to whether sulphur dioxide, oxygen, and steam, at 100°, combine to form hydrogen sulphate. This question, which is of interest in relation to the formation or non-formation of sulphuric acid in the combustion of ordinary coal-gas, the author has endeavoured to answer in the present paper. He has observed very carefully whether any diminution of volume takes place when SO_2, O, and steam at 100° are left in contact in McLeod's gas analysis apparatus. No contraction was observed as long as the temperature remained at 100°. On cooling the mixture so as to allow water to condense, a distinct contraction took place; thus a mixture of 38·98 c.c., after standing for two hours at 5°, measured 38·91, and after standing for two hours at 0°, measured 38·86 c.c. The author concludes that sulphurous acid is unoxidised in a damp atmosphere as long as the temperature is above the dew-point, and that the sulphuric acid in a gas-lighted room is formed by the oxidation of hydrogen sulphite, which is first produced by the solution of sulphurous acid in water condensed on cold and hygroscopic surfaces.

Dr. Armstrong thought that the experiments shewed that H_2SO_3 could not exist in a gaseous state, as it was already known that SO_2 could not be oxidised by O under these conditions.

Mr. Kinozett asked if the conditions of the above experiments fully reproduced the conditions existing in a gas jet; there was an enormous difference in the temperatures employed in the two cases, and probably at the high temperature of a gas jet, H_2SO_4 might be formed.

Mr. Page said that temperature had a great deal to do with the oxidation, and instanced the old Letheby sulphur apparatus, in which the quantity of sulphate produced was very much increased when the cylinder was kept hot by some non-conducting covering.

Mr. Dixon said that no H_2SO_4 was produced in an ordinary gas flame, but if the products of combustion were rapidly sucked into cold water, all the sulphur was obtained as H_2SO_3.

"*On the Reduction of Cinnamic Alcohol*," by F. Hatton and W. R. Hodgkinson. When cinnamic alcohol is acted on by sodium amalgam in the presence of a large

quantity of water, almost the sole product is β-phenyl-propylic alcohol. If, however, an amalgam containing about 15 per cent of sodium be employed, with but a small quantity of water the reaction proceeds much further. Cinnamic alcohol from storax, boiling between 248° and 252° was digested in a steam-bath with sodium amalgam for 3 or 4 days. Water was then added and the whole distilled in steam. A quantity of an oily body distilled over, which, on distillation, boiled 140° to 147°, and by its odor and analysis was identified as cinnamene. The aqueous portion of the distillate was neutral, but rapidly decolourised a solution of potassic permanganate. It was treated with permanganate until a pink colour remained. On evaporation a potassic salt was obtained, which was converted into a lead salt and analysed; it proved to be a formate. The ultimate reaction is, therefore,—

$C_6H_5.CH : CH.CH_2OH + H_2 = C_6H_5.CH.CH_2 + CH_3OH$;

neither α- nor β-phenyl-propylene appear to be formed when the cinnamic alcohol is nearly anhydrous.

The Society then adjourned to May 5, when a ballot for the election of Fellows will be held and the following papers read:—"On the Action of Humic Acid on Atmospheric Nitrogen," by E. W. Prevost; "On the Active and Inactive Amylamines," by R. T. Plimpton; "On the Products of the Action of Alkalies on Ethyl-β-ethyl-acetosuccinate," by T. D. Thorne; "On the Action of Sodium Alcoholates on Fumaric Ether," by T. Purdie.

NOTICES OF BOOKS.

Some Recent Methods of Testing Portland Cement. By Alderman W. H. Bailey (Salford). Manchester: Herald and Waker.

To deal with this pamphlet is no easy task. The "testing" of Portland cement does not refer to its chemical composition, but to its mechanical properties. In consequence, we can scarcely be expected to pronounce with confidence or authority as to the value of the methods discussed. The author remarks that the most popular method of testing Portland cement is by a severe tensile strain, but that "much can be said in favour of testing by compression," and for this purpose he has designed a hydraulic compressor, which was exhibited at a meeting of the Manchester Association of Employers, Foremen, and Draughtsmen, before whom Mr. Alderman Bailey's paper was read, and which is figured and described here. He also gives an account of Prof. Thurston's machine for testing cement by torsion, and of a method of testing, based on tensile strain, and introduced by Mr. Jacob, the Borough-Engineer of Salford. Concerning the comparative merits of these procedures we are unable to decide.

CORRESPONDENCE.

ESTIMATION OF FAT IN MILK.

To the Editor of the Chemical News.

Sir,—I read in the Chemical News, vol. xliii., p. 170, the paper by Mr. Hamlet on the above process. His method seems to me to be, while very ingenious, unnecessarily tedious.

The plan which I have adopted for some years and which gives most accurate results is the following:—I use conical flat-bottom flasks, about three or four inches in diameter. I weigh out about 10 grms. of milk into them, which forms a thin film over the bottom; the flasks are put into the water oven, and in about two hours the milk is dry. Ether is then poured on, the flask corked, and allowed to stand all night. In the morning the flask is connected with a Liebig's condenser, the ether boiled by means of hot water; when the flask is cool the ether containing the fat is poured off into a similar flat-bottom flask. This is repeated about four times, ether being condensed at each operation. The fat is obtained in one flask, and the solids not fat in the other. This method I consider preferable to passing the ether through a tube containing the solid matter, for I have found from experience that the fat is not all extracted by merely passing the ether over the solid matter; that is my reason for leaving the ether on all night.—I am, &c.,

J. Carter Bell.

THE SOCIETY OF CHEMICAL INDUSTRY.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 185, "F.C.S., F.I.C.," wishes to know how far the sub-division of Chemical Society is to be carried, and proposes an alternative to the course adopted by the promoters of the new Society. May I, as an interested person, be permitted to ask why he did not, during the twelve months or more that this project has been under consideration, at the meetings, or by letter, as invited by the committee appointed to discuss such matters, give us the benefit of his ideas, which might then have been of some practical use, instead of keeping them all to himself and coming forward now with a heap of afterthought, to throw as a damper upon the final decision of the committee, and upon the prospects of what appears to be, so far, a very promising undertaking.

As regards the two institutions of which your correspondent is a member, the Chemical Society has nothing in common with the proposed new association, though it might certainly have accomplished the desired object by the formation of a technical section as suggested by your correspondent, and this might possibly have been more advantageous to chemists generally than the establishment of a separate technical institution.

The Institute of Chemistry was formed some three years ago for some purpose or other, partly, I believe, to give us by examination or otherwise, something analogous to the qualification conferred by the Pharmaceutical Society upon its members, but it appears to me that the rules for the admission of members, &c., are such as will eventually strangle the Society, by preventing the admission of the very class which ought to be the backbone of such an association, namely, the technical chemists themselves.—I am, &c.,

Caustic Alkali.

SPONTANEOUS IGNITION OF HYDROCARBON VAPOURS.

To the Editor of the Chemical News.

Sir,—As your space has lately been occupied by much that is of great interest to tar distillers, perhaps you will kindly find room for a subject equally interesting to some of them. Some short time since, I had the misfortune to have my pitch cooling chamber destroyed by an explosion; which, as there was no evidence to show that it had been occasioned directly or indirectly by the ordinary means of ignition, has led me to believe that it is possible under certain circumstances—it may be of temperature or the various proportions of atmospheric air which may get mixed with the hot hydrocarbon gases—for the mixture of vapour to ignite spontaneously.

If this theory is correct, and I am led to understand that many tar distillers hold this view, I shall be glad to have any information that may tend to explain the cause of such explosions (which fortunately are not so alarmingly frequent, though serious enough when they occur), as, perhaps, with a knowledge of the laws of their cause, they might in many cases be prevented.—I am, &c.,

Hydrocarbon.

AN AVOWAL.

To the Editor of the Chemical News.

As one who at the first meeting of the Society of Chemical Industry cast some ridicule on the newly introduced profession of "Chemical Engineer" ("Ch.E."?), permit me now to frankly confess that I believe I was mistaken.

Though I took honours at college in chemistry and physics, and am a successful inventor of chemical plant and processes, nevertheless, because I am not a chemical manufacturer "on my own hook," I found myself, with the census form before me, an animal of a nondescript genus. Thanks, however, to those who were the first to practically realise the dignity and national importance of their calling, there was a way out of the quandary. With a good conscience I described myself as a

CHEMICAL ENGINEER.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 12, March 21, 1881.

The Possibility of Rendering Sheep Proof against Splenic Fever by the Method of Preventive Inoculation.—M. Pasteur.—The author, whilst agreeing with M. Toussaint as to the successibility of this treatment, criticises certain opinions advanced by the latter.

Researches on the Formic Ethers.—MM. Berthelot and Ogier.—The formic ethers, like acetic ether and the oxalic ethers, are formed with absorption of heat from the alcohol and the acid.

Distribution of Energy in the Normal Solar Spectrum.—S. P. Langley.—The total quantity of heat poured by the sun upon the earth is much greater than has been supposed. Previous to the atmospheric absorption this maximum must lie much nearer the violet than the extreme red. The totality of the solar radiations, if it could reach us, would give a sensation of blueness rather than of whiteness. The atmosphere which we regard as transparent plays the part of a strongly coloured medium.

Synthetic Apparatus Reproducing the Phenomenon of Double Circular Refraction.—M. Gouy.—Not capable of useful abstraction.

The Radiophony Produced by the Aid of Selenium. E. Mercadier.—The sounds produced in the selenium receivers which the author has studied result chiefly from the action of the luminous vibrations. The rays of the spectrum act from the limit of the blue towards the indigo as far as the extreme red, and even a little below the red. The indigo, violet, and ultra-violet rays are without perceptible effect. The maximum action is always in the yellow portion of the spectrum. Glass tube receivers containing air in contact with a smoked surface gave a very different result. The active rays extended from the orange beyond the red to a limit which may be at the third or fourth the length of the visible spectrum, the maximum effect being in the lower red. The other radiations of the spectrum from the yellow to the ultra-violet do not produce any sensible effect. The action is chiefly thermic.

Experiments made at the Creusot Works for the Optical Measurement of High Temperatures.—A. Crova.—The author found that the most convenient method consisted in projecting by means of a lens the image of a circular aperture, made in the outer door of a Martin-Siemens furnace, upon the reflector prism of the spectro-pyrometer. It was easy to observe, even in full daylight, the two spectral bands of the red and green regions taken as fixed points of the optical scale. When the furnace was in a state of normal activity the optical degree obtained corresponded to a temperature of about 2000°. The temperature of melted steel was about this point, and that of cast-iron when running into the orifice of the Bessemer converters varied from 1110° to 1150°. The flame of the Bessemer converters did not admit of measurement on account of the green bands which appeared in its spectrum. The measurement of temperatures below 1000° presents difficulties which may be overcome by a modification of the instrument.

Electro-motor Forces of the Galvanic Arc.—F. P. Le Roux.—Not susceptible of useful abstraction.

Hissing of the Galvanic Arc.—A. Niaudet.—The arc sometimes gives rise to a hissing, which under certain circumstances may become an intense noise. The author finds from his experiments that the difference of potential between the two carbons has two very different stages, the greater when the arc is silent and the smaller when it hisses. The needle of the galvanometer springs abruptly from one region to another when silence begins or ceases. The smallest, the most momentary noises, are reproduced by a movement of the needle. When silence is well established the needle may remain steady for a long time.

Magic Mirrors of Silvered Glass.—L. Laurent.—The so-called magic effect may be produced by the manner of fixing the mirror in its frame.

Efflux of Gases.—M. Neyreneuf.—The verification o the laws of efflux of gases may be effected by a process which recalls the methods in use for the determination of electric resistances.

New Compounds of Hydrobromic and Hydriodic Acid with Ammonia.—L. Troost.—The first of these compounds consists of 1 equiv. hydrobromic acid and 2 equivs. ammonia. It is anhydrous and has no analogue among the compounds of hydrochloric acid with ammonia. A second compound is a tetra-ammoniacal hydrobromate. It is anhydrous and melts at +6°. A third compound is the hepta-ammoniacal salt which melts at −20°. Hydriodic acid forms analogous compounds.

Action of Hydrochloric Acid upon Lead Chloride.—A. Ditte.—In the author's memoir on the action of hydrochloric acid upon the metallic chlorides he has omitted lead chloride, which behaves in a special manner. The solubility of this salt in water decreases at first as increasing proportions of acid are added, but with a further increase the solubility of the salt becomes greater. Lead bromide and iodide behave in a similar manner in presence of their respective hydracids.

Behaviour of Sulphuric Acid recently Heated to 320° with Oils.—E. J. Maumené.—Acid recently heated, without having lost the least trace of water, presents very different reactions from those of the same acid which has been prepared for some time, at least as far as the liberation of heat is concerned. Upon this reaction the author has based a method for the analysis of oils, which has been confirmed by Fehling. It being required to show the difference among numerous specimens of linseed oil, according to their source, age, &c., two series of assays were made, the one with ordinary acid at 83·5° (densimetric), the other with the same acid heated to 320°, cooled, and used after it had assumed its ordinary temperature. In these two series the quantities of heat liberated were respectively very different, the acid recently heated developing very much higher temperatures. The results furnished by this process are constant with one and the same acid, and may be obtained with 25 c.c. of oil and 5 of acid.

A New Method for the Analysis of Oils.—E. J. Maumené.—The author treats a measured quantity of oil with a measured quantity of standard caustic alkali. Ten c.c. of oil measured with a pipette were heated in a boiling water-bath for an hour with 20 c.c. of a solution of

potassa, which would neutralise 123 c.c. of sulphuric acid at 98 grms. = 1000 c.c. At the end of this heating the linseed oils mentioned in the previous memoir all yielded a cake of soap, solid or very firm when hot, always solid when cold, and easily separated by mere draining. The alkaline solution is very differently acted upon by different samples. It still neutralises smaller quantities of acid, differing in case of every sample.

Separation of Nickel Oxide and Cobalt Oxide.—G. Delvaux.—The author proposes to give a process for the separation of the two metals, derived from two known methods, and permitting the exact determination of the two oxides, and the preparation of the two metals in a state of purity. The two fundamental processes are that of Pisani, who uses caustic potassa in presence of an ammoniacal liquid, in which are dissolved the two metals, with exclusion of air. The nickel oxide is precipitated alone in bulk, but always carries down with it more or less of cobalt oxide. The second method is that of Terreil, who precipitates cobalt in an acid solution in the state of roseo-cobaltic hydrochlorate. The cobalt oxide is peroxidised by means of permanganate. We suppose that the two bodies, cobalt and nickel, have been obtained by known methods, either as pure oxides or pure sulphides, free from all foreign matter. The mixed oxides or sulphides are dissolved in an *aqua regia* containing a large proportion of hydrochloric acid. The solution is largely diluted with water and saturated with ammonia in excess. Permanganate is then added until the solution remains rose coloured for some time. Pure potassa is then added, when the nickel is precipitated as hydroxide, carrying with it manganese oxide, derived from the permanganate. The precipitate is washed by decantation and filtered; redissolved in hydrochloric acid, and treated again with ammonia, permanganate, and caustic potassa. The washing-waters which contain the cobalt are collected, saturated with acetic acid, and precipitated by sulphuretted hydrogen. The mixture of nickel and manganese oxides is re-dissolved in hydrochloric acid, and the solution saturated with ammonia. The solution is exposed to the air for some time, and the manganese oxide is by degrees entirely precipitated. It is filtered off, the filtrate is saturated with acetic acid, and the nickel thrown down by means of sulphuretted hydrogen. The process may be employed on the large scale for obtaining nickel completely free from cobalt.

A Process for the Industrial Preparation of Potassium Carbonate.—R. Engel.—Potassium chloride may be directly converted into carbonate in the following manner:—Magnesium oxide or carbonate is added to the aqueous solution of potassium chloride, and the mixture is added in presence of carbonic acid. There is formed magnesium bicarbonate, which dissolves, reacts upon the potassium salt, and precipitates it as a double carbonate of the two bases. This precipitate is crystalline and may be easily separated from the mother-liquors. If it is heated, either dry or in presence of water, carbonic acid escapes, and the double salt is resolved into potassium carbonate and magnesium carbonate, which are separated by water. The carbonate of magnesia serves for a fresh operation.

Certain Complex Compounds of Sulphur and Nitrogen.—Eug. Demarçay.—The compounds in question are dithio-tetra-thiazyle bichloride and thio-dithiazyle bichloride. For their preparation and properties we must refer to the original memoir.

The Tar of Cork.—L. Bordet.—Cork-waste has been for some time used for the manufacture of lighting gas. The products are at once analogous to those yielded by wood and by coal. The author has obtained acetic acid and methylic alcohol ammonia and hydrocarbons similar to those of coal. The ketons characteristic of wood-tar are wanting.

Journal für Praktische Chemie.
Parts 5 and 6, 1880.

Analysis of the Kaniz or Kainzen Spring.—F. Hulwa.—This spring is distinguished by the absence of free carbonic acid and the abundant occurrence of sodium carbonate.

How to Write a Chemical Manual.—H. Kolbe.—A somewhat caustic notice of the "Chemistry of Carbon Compounds," by Dr. V. von Richter.

A Curiosity.—It is announced that Otto Fischer will give lectures at the University of Munich on "Aromatic Chemistry." The editor asks if a course on "Fatty Chemistry" is to follow?

Parts 7 and 8, 1880.

Volume-Chemical Studies.—III. On the Mass-Action of Water.—Dr. W. Ostwald.—As early as 1847 H. Rose pointed out the important part played in chemical reactions by the "mass action" of water, and he showed by a series of examples that this liquid, formerly considered as indifferent, can develop very noteworthy affinities. The following researches refer to the reciprocal action between sodium sulphate, sulphuric acid, and water. Four solutions of sodium sulphate were prepared, in each of which 1 atom (= 142 grms.) was dissolved respectively in 1, 2, 3, and 4 kilos. of water. Four corresponding solutions of sulphuric acid were prepared, and each sulphate solution was mixed with each sulphuric acid solution in five proportions, 1 vol. sodium sulphate being respectively mixed with ¼, ½, 1, 2, and 3 vols. of the sulphuric acid. Among other results it appears that in presence of large quantities of water with an excess of sodium sulphate a greater quantity of the acid salt remains undecomposed than with an equivalent excess of sulphuric acid; the latter is more interfered with in its action than the former by its affinity for water.

Arsenic Sulphide as a Poison, and its Import in Judicial Investigations.—J. Ossikovsky.—The question was raised whether in a certain dish of cabbage containing arsenic sulphide, there was poison enough to prove fatal to a man. From a number of experiments the author concludes that arsenic sulphide, whether prepared in the moist way, or the orpiment of commerce used by painters, forms, in contact with putrescent organic matter, arsenious and small quantities of arsenic acid. In cases of poisoning with arsenic sulphide these oxidation-products appear sooner or later according to circumstances. Hence, if articles of food, vomited matter, &c., are only sent for chemical examination after the interval of weeks, or perhaps months, the expert cannot give a definite answer to the question whether the poison was sufficient in quantity to prove fatal to a man.

Process of Decomposition in a Putrefying Hen's Egg.—Dr. C. O. Cech.—It appears that in the north of Russia some wholesale dealers have each season to dispose of more than 500,000 bad eggs. The author finds that such eggs may be classed in seven groups, according to the stage of decomposition. He proposes to extract the so-called egg-oil, which may be used in the manufacture of soaps. He afterwards suggests that putrid eggs may be applied in the manufacture of artificial manure.

The Disinfective Action of the Chlorphenols.—Dr. C. O. Cech.—Trichlorphenol appears to have the greatest disinfective power. The corrosive and poisonous properties of phenol decrease with an increasing proportion of chlorine.

Occurrence of Nitrates in Certain Vegetable Raw Materials and their Determination.—Isidor Bing.—The author has detected and determined nitrates in four kinds of tea, in maté, coffee, and valonia. The author used Tiemann's method as modified by Schulze (see *Berichte Deutsch. Chem. Gesell.*, 1873, p. 1038).

Two Remarkable Cases of Metamerism in Organic Compounds.—Dr. L. Schreiner.—The author has ob-

tained methyl-carbonic ethyl-ether, $CH_3O(CO)OC_2H_5$, and ethyl-carbonic methyl-ether, $C_2H_5O(CO)OCH_3$. The latter compound has the same odour as the former, but a lower sp. gr, and boils under a pressure of 730·1 m.m. at 115·5°, *i.e.*, more than 10° higher than the former. The author has also obtained ethyl-methyl-urea,—

$$\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}N(CO)N\left\{\begin{matrix}CH_3,\\H\end{matrix}\right.$$

and methyl-ethyl-urea,—

$$\left.\begin{matrix}CH_3\\H\end{matrix}\right\}N(CO)N\left\{\begin{matrix}C_2H_5,\\H\end{matrix}\right.$$

The former body melts at 105° and congeals again at 101°. The latter melts at 75° and congeals at 72°.

Remarks on the Foregoing Memoir.—G. Hüfner.—Dr. Schreiner not having the opportunity to continue these researches they will be taken up by the writer.

Remarks on the above Paper.—H. Kolbe.—The author criticises the views of Kekulé, of which he enumerates five: The dogma of the constant valence of the elements; the dogma of the equal valence of the four units of affinity of quadrivalent carbon; the dogma of the movement of atoms in the molecule; the dogma of the equal valence of the six hydrogen atoms of benzol, and the dogma, or, more correctly, the invention of the benzol ring. The second of these being dispelled by the researches of Dr. Schreiner, the fourth and fifth fall to the ground, and of the dogmas of the so-called modern chemistry there remains nothing but undeception.

Certain Derivatives of Isophthalic Acid.—Bruno Beyer.—The author has prepared isophthalylamide, and has commenced the study of the nitro-isophthalic acids.

Researches on the Physical Chemistry of the Blood.—G. Hüfner.—A long and illustrated memoir, which does not admit of useful abstraction.

Analysis of the Mineral Spring of Niederbroun in Alsace.—Dr. E. Burt.—The mud deposited by this water contains arsenious acid, lead sulphate, ferric oxide, and traces of antimony, copper, zinc, and manganese.

Oil of Coffee.—C. O. Cech.—The oil in question is green, transparent, and flows slowly. The author's researches are incomplete.

Colouring-Matter of Rubus Chamæmorus.—C. O. Cech.—Cotton, wool, and silk—the last-mentioned fibre least completely—quickly take an intense and permanent orange if boiled with the juice of these berries. The author recommends it as a cheap and useful dye for buff, amber, and orange shades, and for giving white wines a Tokay or Sherry colour. The berry is perfectly harmless.

Chemiker Zeitung.
IV., No. 19.

Retrospect of the Progress of Pure Chemistry in the First Quarter of 1880.—"To Crookes, the celebrated discoverer of thallium and of the radiometer, and editor of the Chemical News, belongs the merit of drawing the attention of the scientific world to those movements of gases which take place in highly exhausted receivers under the influence of electric currents. After having communicated two papers on this subject to the Royal Society of London in 1878 and 1879, there appeared in the Chemical News his treatise 'On Radiant Matter,' which was quickly known and discussed amongst us. Whilst he performed his brilliant experiments in Paris before a select circle of French men of Science, German investigators, and especially Wiedemann and Gintl, considered that his conclusions were incorrect, and that his assumption of radiant matter as a fourth state of aggregation was unfounded. Still, in spite of his treatise containing much that was already known, it is the indisputable merit of this gifted English experimentalist to have brought together all the known facts and explained them by excellent illustrations. The charge that Crookes has too little regarded German researches, especially those of Hittorf and Goldstein, may be justified.* But the treatise contains a great number of original ideas."

Nitric Acid Injector.—Fr. Bode.—This contrivance for introducing nitric acid into the chambers cannot be intelligibly described without the accompanying illustration.

Rapid Detection of the Presence of Water in Alcohol and Ether.—Carl Mann.—If an aqueous solution of 2 parts crystalline tartaric acid is mixed with 1 part of molybdic acid and evaporated to incipient fusion in a porcelain capsule, the deep blue mass which is formed, if heated with 30 to 40 parts of water, yields along with a fixed residue a faint yellowish brown filtrate, holding in solution the citrate of a molybdenum compound, which has the property of appearing deep blue in its anhydrous state, but almost colourless when hydrated. If a slip of filter-paper is steeped in this molybdenic solution (not too dilute) and dried at 100°, the blue colour reappears with great intensity. The paper, if screened from direct sunlight retains its colour. If it is plunged in pure water the blue colour disappears at once; the paper becomes white and the water is not coloured. At 50° the decolouration is instantaneous; at 18° to 20° in two or three seconds, and at 10° in five to eight. With absolute alcohol or ether in a stoppered bottle the blue colour of the paper remains unaffected. This reagent for water is not acted on by aceton, aldehyd, methylic alcohol, and mixtures of amylic and ethylic alcohol. If plunged in spirit of wine the blue colour disappears more rapidly the more water is present.

Researches on the Radiant Matter of Crookes and the Mechanical Theory of Electricity.—Dr. W. F. Gintl, abstracted by Dr. von Gerichten.—The author discusses the question whether, according to the experiments of Crookes, the assumption of an especial fourth state of aggregation is necessary, or whether the facts may be satisfactorily explained without such hypothesis? He shows that the latter alternative is possible with the aid of a mechanical theory of electricity. If the radiant matter produced in the vacuum is a phenomenon *sui generis*, produced by the action of electricity and heat upon the molecules of gas remaining in the receiver, it is in the first place doubtful to apply to it the conception of an aggregate condition. The author considers it impossible to form a clear understanding of the phenomena in accordance with the theory of Crookes, or to find in the facts any evidence of the existence of radiant matter. An explanation of the latter phenomenon is thus given:—Particles become separated from the surface of the substance of the negative pole, they are repelled, and they move away from the pole with a speed resulting from the antagonistic forces in a parallel and rectilinear direction, preserving their speed and their initial path so long as they do not meet with obstacles which influence their movement. At a certain density of the gases present in the exhausted space, these particles, in consequence of the impact of gaseous molecules more or less opposed to their direction of movement, lose their velocity after travelling a short distance and soon come to rest. The more dilute the gas the smaller is the number of the impacts of the gaseous molecules encountering the molecules of the poles, and at a certain degree of dilution the repelled polar particles will be able to traverse the space open to them without any essential alteration in their speed, the small number of the existing gaseous molecules being no longer able to retard the molecules of the polar on their journey through the apparatus. The luminous phenomena of the

* The authors of this charge have evidently only seen abstracts of my paper. Had they taken the trouble to refer to the original paper "On the Illumination of Lines of Molecular Pressure and the Trajectory of Molecules," published in the *Phil. Trans. of the Royal Society*, Part I., 1879, being the Bakerian Lecture for the year 1878, they would see that full credit is given to the researches of both Hittorf and Goldstein.—W. C.

Geissler tubes the author supposes to be produced by the intense blows which the gaseous molecules receive from the polar molecules flying rapidly through the apparatus. The intensity of the luminous phenomena will naturally decrease with the number of the photophorous particles occupying the space. Accordingly in the experiments of Crookes, on continued rarification of the gas, a condition was reached where a display of light is no longer perceptible, or can be made visible merely by the aid of fluorescent bodies. A condition may also appear, as is shown by Crookes's experiment, with the metallic plate intercalated as negative pole in the middle of a Geissler tube, with the positive poles at the ends. In this case the gaseous molecules are, so to speak, driven away by the polar particles endowed with an equal initial velocity, till at a certain distance from the pole the mass of the gaseous molecules and their speed become so great that a luminous display begins. In an analogous manner the author explains the phenomena of phosphorescence which Crookes elicits by the action of his radiant matter. In like manner the thermic and the mechanical effects are most simply explained, according to the expression selected by Crookes himself as the results of a "continued molecular bombardment." The attraction of the so-called radiant matter, regarded as a stream of metallic particles, by the magnet will not appear surprising.

Justus Liebig's Annalen der Chemie,
Band 205, Heft 2.

Certain Derivatives of Isobutyl-aldehyd.—Andreas Lipp.—The author examines the behaviour of this compound with ammonia, and the reaction of the isobutyl-aldehyd-ammonia compound thus obtained with hydrocyanic acid, obtaining thus amido-isovaleronitril, the corresponding amide; also α-amido-isovalerianic acid, imido-isovaleronitril, hydroxisovaleronitril, hydroxisobutyl-formic amide, with the corresponding acid and its salts.

Action of Sulphuric Acid upon Substituted Nitro- and Amido-Benzols.—Jul. Post.—This very lengthy memoir treats of the sulphuration of para-nitro-phenol, the nitration of ortho-sulpho-phenol, the amidation of the same compounds; the examination of the amido-sulpho-phenols obtained by different methods concerning their identity and isomerism; the transformation of ortho-sulpho-phenol into the para- compound; a description of the ortho-nitro-ortho-amido- and diortho-amido-phenols, and of their nitro-substitution-products; the introduction of bromine and iodine into para-nitro-ortho-sulpho-phenol; the sulphuration of nitramido- and diamido-benzol both in the ortho- and the meta- series, and the formation of amido-sulpho-benzols both from nitro-benzol and from aniline in order to prove the difference of the respective products.

Experiments on the Oxidation of Nitrogenous Methylised Benzol Derivatives.—A. Brückner.—The compounds operated upon are anhydro-benzamido-para-toluilic acid, anhydro-diamido-para-toluil-xylol, and the benz-toluidines.

The Constitution of Benzol.—Julius Thomsen.—The author concludes from his experiments that the six carbon atoms of benzol are linked together by nine simple connections, and the prevalent assumption of a constitution of benzol with three simple and three double connections does not agree with experiment.

Discovery of Methylamines in Commercial Trimethylamine-hydrochlorate.—L. J. Eisenberg.—The double salt prepared from the commercial hydrochlorate is perfectly identical with the trimethylamine-hydrochlorate obtained by Hofmann from the brine of herrings.

Moniteur Scientifique, Quesneville.
January, 1881.

Industrial Society of Mulhouse.—Session of Nov. 10, 1880:—

M. Camille Kœchlin recommends the use of naphthol to prevent solutions of albumen from putrefying. It is stirred up in water in the proportion of 250 grms. per litre, and added as may be required.

A letter by M. Gartner was communicated on the use of certain sea-weeds from the Japanese coasts, as substitutes for starch, glue, and albumen.

M. A. Scheurer gave an account of the researches of M. Prud'homme on a new colouring-matter derived from cœruleine.

M. Trampedach, of Mitan, has succeeded in obtaining from blood-serum a colourless albumen, capable of being substituted for egg-albumen in all cases.

M. Witt has resumed the study of the compound $C_{36}H_{29}N_5$, which he obtains by treating diphenyl-nitrosamine with aniline, and also by the action of nitrosophenol on aniline hydrochlorate. M. Kimich's azophenine is probably the same body. This compound, if heated to 250° with concentrated sulphuric acid, is converted into a new colouring-matter, which is not attacked even by boiling sulphuric acid. On the addition of water it gives a sky-blue solution with a strong red fluorescence, and presenting three broad absorption-bands in the red, the yellow, and the green.

The Analysis of Waters.—A. Wanklyn and Th. Chapman.—A translation of the well-known treatise of these chemists.

Detection of Phosphorus in Urine in Cases of Poisoning.—F. Selmi.—The urine passed on the first day gave the following results: it gave off a volatile product capable of reducing silver nitrate without affecting lead acetate. It contains a small proportion of albumen: it contains one of the mineral acids of phosphorus, or at least a compound which is capable of precipitating baryta in an alcoholic solution, and which in presence of nascent hydrogen gives off hydrogen phosphide. It yields a volatile phosphoric product, ammonia, and two volatile bases (one containing phosphorus): these substances distil over along with alcohol. It yields two other non-phosphoric bases, one fixed and the other volatile, which are extracted by chloroform from the aqueous residue after the distillation of the alcohol. Along with the volatile base is found a small quantity of a product having the odour of conicine. The odour of trimethylamine is also perceptible. In doubtful cases the author considers that an examination of the urine yield valuable data.

Memoirs of the Academy of Sciences of Bologna.

Action of certain Non-organised Ferments at Low Temperatures.—F. Selmi.—Amygdalin is easily split up at 0° into glucose, benzoyl hydride, and hydrocyanic acid. At −15° the decomposition is greatly retarded. Human saliva saturated with common salt rapidly converts starch into glucose at 0°. At −20° the conversion does not set in until after a contact of thirty minutes. An aqueous solution of diastase, saturated with salt, converts starch into glucose at 60° to 65°, after an hour's contact. At lower temperatures the reaction does not set in. The pancreatic juice converts starch into glucose in a mixture of salt and snow.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome 8, No. 2, September and October, 1880.

Explosion of the Royal Gunpowder Mills of Wetteren. — Prof. Chandelon. — The catastrophe is ascribed to the conduct of the men in charge of the steam drying apparatus.

Reimann's Färber Zeitung,
No. 1, 1881.

A correspondent states that a quantity of copperas was accidentally thrown into the cistern supplying the boilers in a dye-house. So much hydrochloric acid was evolved by double decomposition with the chlorides present in the

water that the strangest alterations took place in the shades which were being dyed, especially orchil and safflower colours.

No. 2, 1881.

An outcry has arisen in Halle, about poisonous tarletanes got up with copper arsenite. Dr. Reimann points out in reply that copper arsenite is not a "splendid green colour," and that for such goods as tarletanes, Guignet's green, which contains no arsenic, has superseded the poisonous Schweinfurt green.

D'Andiran and Wegelin, of Mulhouse, supply for aniline blacks, not pure aniline, but a mixture of 2 parts aniline and 1 part xylidine or cumidine.

No. 3, 1881.

Kohlrausch proposes to extract tannin, not by boiling powdered astringents, but by reduction to fragments of the size of a nut and treating them in a series of dialysers, the bottom of which is formed of animal membranes, or of parchment paper, and permits the passage of the solution of tannin.

No. 4, 1881.

Guinon proposes to bleach tussah-silks by steeping in soda-lye at 3° B., and at the heat of 100° (!). It loses its gum and 12 per cent of its weight, and is rendered white without loss of lustre. The treatment must not last longer than a quarter of an hour. The silk is then washed, and passed through dilute sulphuric acid. The fibre is not injured, but the affinity for colours is reduced.

No. 5, 1881.

Prof. Merz and Weith, of Zurich, have discovered a new colouring-matter, which they name "sun-gold." Its composition will not be made known till a patent has been obtained. (But Switzerland has no patent-laws!)

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Waterproofing.—I wish to waterproof one side of common sawboard and mill-boad with silicate of soda, and shall feel obliged if one of your readers will inform me of the cheapest plan, and how long it will take to dry hard.—E. J. L.

MEETINGS FOR THE WEEK.

Monday, May 2nd.—Medical, 8.30.
—— Society of Arts, 8. "The Art of Lace-Making," Alan S. Cole.
—— Royal Institution. Annual Meeting, 2.
Tuesday, 3rd.—Civil Engineers, 8.
—— Quekett, 8.
—— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.
Wednesday, 4th.—Society of Arts, 8. "Buying and Selling; Its Nature and Its Tools," Professor Bonamy Price, M.A.
Thursday, 5th.—Royal, 4.30.
—— Royal Institution, 3. "Magnetism," Professor Tyndall.
—— Chemical, 8.30. Ballot for the Election of Fellows. "On the Action of Humic Acid on Atmospheric Nitrogen," E. W. Prevost. "On the Active and Inactive Amylamines," R. T. Plimpton. "On the Products of the Action of Alkalies on Ethyl-β-ethyl-aceto-succinate," L. D. Thorne. "On the Action of Sodium Alcoholates on Fumaric Ether," T. Purdie.
Friday, 6th.—Royal Institution, 8. "The Land Systems of England and of Ireland," Hon. Geo. Brodrick, 9.
—— Geologists' Association, 8.
Saturday, 7th.—Royal Institution, 3. "Scotland's Part in English Literature," Prof. Morley.

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THE CHEMICAL NEWS.

VOL. XLIII. No. 1119.

NOTES ON THE OXIDES OF MANGANESE.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon, F.C.S., Assistant Master at Highgate School.

(Continued from p. 190.)

§ IV. *Experiment with Pure Oxides which had been Dried.*

ALL these oxides, as has already been mentioned, were prepared by the decomposition of manganese sesquichloride by water.

1. *Oxide No.* 4, after being washed, was dried in air at ordinary temperatures, by being placed under a bell-jar over some sulphuric acid. Subsequently it was ground in a mortar, and shaken through fine cambric in order to reduce it to as fine a powder as possible: it yielded on analysis the following numbers :—

MnO_2	61·545 per cent
MnO	8·342 ,,
H_2O	30·113 ,,

From which it is found that the total manganese present constitutes 45·342 per cent, of which—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{85\cdot75 \text{ per cent}}{14\cdot25 \text{ per cent}} = 6\cdot02.$$

This oxide, as will be observed on an examination of Table IV., showed a very considerable loss of oxygen on being heated at 100° C., the only temperature at which any experiments were made with it.

2. *Oxide No.* 5.—This oxide was dried in an air-bath at 29° to 40° C., and sifted through cambric, like the preceeding and following specimens. Its composition was—

MnO_2	69·618 per cent
MnO	9·084 ,,
H_2O	21·298 ,,

Whence, total manganese present = 51·028 per cent, and—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{86\cdot17 \text{ per cent}}{13\cdot83 \text{ per cent}} = 6\cdot239.$$

Here we find a very much smaller loss of oxygen is experienced on heating at 100° C. than in the former case, although the latter oxide contained rather more dioxide than the former, and might consequently have been expected to suffer a greater loss.

3. *Oxide No.* 6.—This oxide, after being dried in an air-bath at about 70° to 80° C., gave the following numbers on analysis :—

MnO_2	85·149 per cent
MnO	9·356 ,,
H_2O	5·490 ,,

And hence the total manganese present is 61·057 per cent, of which—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{88\cdot13 \text{ per cent}}{11\cdot87 \text{ per cent}} = 7\cdot423$$

This oxide lost considerably more oxygen than the preceding sample, but not half as much as No. 4 did, although it was a good deal richer in dioxide than this latter. It will also be noticed that in this case the loss is not increased to any great extent by raising the temperature from 100° to 200° C.

§ V. *Experiments on Pure Oxides which had not been Dried.*

Since in the preceding cases oxygen was found to be evolved by these oxides at so low a temperature as 100° C., it was thought possible that they might have experienced a certain loss also, even at the temperatures at which they were dried, and, therefore, that if experiments were made on the oxides before any attempts whatever had been made to deprive them of water, a far more marked alteration might be effected on heating them. The only manner of experimenting on this point which suggested itself was one which gave little promise of success, but which, however, eventually proved to give very trustworthy results. It consisted in removing the hydrated oxide from the filter as soon as it had been thoroughly washed, and stirring it in a mortar with sufficient water to form a thin paste. Various portions of this paste, as nearly equal in amount as possible, were put into as many tared watch-glasses as were requisite for all the experiments on the samples in question; they were then weighed, and by weighing the last watch-glass full, both immediately before and immediately after weighing the rest, it was easy to obtain data by which the loss of water by evaporation during the weighing could be approximately allowed for. The errors to which this method of operating are obviously open were so far counterbalanced by taking a considerable amount for each experiment (5 or 6 grms.) that very fairly concordant results were obtained

TABLE IV.

Experiments on Dried Oxides obtained by the Decomposition of Mn_2Cl_6.

	Oxide.	Ratio of Mn as MnO_2 to Mn as MnO.	Conditions of Experiment.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Alteration in the MnO_2 found.
67	No. 4*	6·02 : 1	Before heating	61·760	61·545	
68	,,	,,	,, ,, ...	61·320		
69	,,	,,	,, ,, ...	61·551		
70	,,	,,	After heating at 100° C.	60·066	60·032	2·458 per cent loss.
71	,,	,,	,, ,, ,,	60·033		
72	,,	,,	,, ,, ,,	59·997		
73	No. 5†	6·239 : 1	Before heating	69·791	69·618	
74	,,	,,	,, ,, ,,	69·545		
75	,,	,,	After heating at 100° C.	69·053	69·143	0·682 ,, ,,
76	,,	,,	,, ,, ,,	69·204		
77	,,	,,	,, ,, ,,	69·131		
78	No. 6‡	7·423 : 1	Before heating	84·939	85·149	
79	,,	,,	,, ,, ,,	85·359		
80	,,	,,	After heating at 100° C.	84·189	84·242	1·065 ,, ,,
81	,,	,,	,, ,, ,,	82·295		
82	,,	,,	,, ,, 200° C.	83·473	83·621	1·795 ,, ,,
83	,,	,,	,, ,, ,,	83·769		

* Dried over sulphuric acid in air and ordinary temperatures. † Dried in air at 29° to 40° C. ‡ Dried in air at about 70° to 80° C.

TABLE V.

Experiments on Moist Oxides obtained by the Decomposition of Mn_2Cl_6.

	Oxide.	Ratio of Mn as MnO_2 to Mn as MnO.	Conditions of Experiment.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Alteration in the MnO_2 found.
84	No. 4	6·014 : 1	Before heating	4·095		
85	,,	,,	,, ,, ...	4·114	4·102	
86	,,	,,	,, ,, ...	4·097		
87	,,	,,	After heating at 100° C.	3·986		
88	,,	,,	,, ,, ,,	3·990	3·993	2·657 per cent loss.
89	,,	,,	,, ,, ,,	4·002		
90	,,	,,	,, ,, 200° C.	3·730		
91	,,	,,	,, ,, ,,	3·753	3·742	8·776 ,, ,,
92	No. 7	?	Before heating	4·616		
93	,,	,,	,, ,, ...	4·622	4·619	
94	,,	,,	After heating at 100 C°.	4·356		
95	,,	,,	,, ,, ,,	4·322	4·339	8·227 ,, ,,
96	,,	,,	,, ,, 200° C.	4·143		
97	,,	,,	,, ,, ,,	4·175	4·159	9·96 ,, ,,
98	No. 8	7·27 : 1	Before heating	13·014		
99	,,	,,	,, ,, ...	13·203	13·107	
100	,,	,,	,, ,, ...	13·103		
101	,,	,,	After heating at 100° C.	12·020		
102	,,	,,	,, ,, ,,	11·954	11·989	8·53 ,, ,,
103	,,	,,	,, ,, ,,	11·992		

in every case, as may be seen from an inspection of Table V. Thus for instance, in the case where the dioxide present in the sample amounted to about 4 per cent, the extreme variation of any one experiment on either side of the mean is 0·017 per cent, and the mean variation is only 0·0098 per cent, which corresponds to 0·245 per cent of the total manganese dioxide found, this being less than one-tenth of the minimum change in dioxide value which ever had to be measured, and about one-thirty-sixth of the alteration measured in most of the cases.

1. *Oxide No.* 4. This was the same oxide as one of the samples mentioned in the preceding paragraphs. It was formed to contain—

MnO_2	4·102 per cent.
MnO	0·556 ,,
HnO	95·342 ,,

Whence the total manganese present is 3·023 per cent, of which—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{85{\cdot}74 \text{ per cent}}{14{\cdot}26 \text{ per cent}} = 6{\cdot}014.$$

These last numbers, which are accidentally coincident with those above quoted, far within the limit of experimental error, show that the oxide was not appreciably altered, as far as manganese and oxygen were concerned, by being dried over sulphuric acid: moreover, on comparing the results given in Table IV. with those given in Table V., we see that the loss of oxygen which it experienced on being treated at 100° C. was practically the same both before and after being dried. This loss, in the case of the moist oxide, is more than trebled by raising the temperature from 100° to 200° C.

2. *Oxide No.* 7.—Of this oxide, unfortunately, no complete analysis was made, but from the Table it will be seen that the loss of oxygen which it experiences at 100° C. is nearly as great as that experienced by the previous specimen at 200° C., and that by raising the temperature up to this latter point the loss of oxygen is only increased by abouth one-fifth.

3. *Oxide No.* 8 gave the following analytical results:—

MnO_2	13·107 per cent
MnO	1·471 ,,
H_2O	85·422 ,,

Whence the total manganese present constitutes 8·397 per cent, and of this—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = \frac{87{\cdot}91 \text{ per cent}}{12{\cdot}09 \text{ per cent}} = 7{\cdot}270.$$

This oxide at 100° C. lost even more oxygen than the previous one.

ON THE DETECTION OF ARTIFICIAL COLOURING MATTERS IN RED WINES BY MEANS OF THE SPECTROSCOP E

By H. MACAGNO.

My last paper,* "On the Detection of Aniline Colours in Wines," will be perhaps of not much practical interest, because processes to ascertain their presence are already well known.

Although spectroscopic observation is a rapid and expeditious method to determine not only the presence but also the quality of the colours employed, the analyst would be easily mistaken in detection of aniline colours when to a wine containing *orseille* one of the ordinary processes is applied, as will be hereafter shown.

Artificial colouring matters—viz., hollyhock, cochineal, Portugal berries, bilberries, &c.—do not give such characteristic reactions as might be desirable for their detection. The tints produced by many reagents, as indicated in the handbooks of practical chemistry, do not react well; they are not well defined, and their detection is in consequence always uncertain. In such cases I think the spectroscope is very useful as a means of sure determination of the nature and quality of various tints resulting from different reactions.

I obtained in this way, with several colouring matters commonly mixed with red wines, a series of very characteristic and well-defined absorptions, œnolin being driven away by special treatments hereafter mentioned.

Orseille (lichen red).—This substance is soluble in ethylic and acetic ethers, and when aniline colours are sought for in a wine by ordinary processes, one can be led into a great error. But the ethereal solution observed by the spectroscope gives the following absorption†:—

Which evidently shows that aniline compounds are not the active agents here.

* Chemical News, vol. xliii., p. 169.

† See my last paper (*Ibid.*) on this means of representing absorptions and on the bands of aniline colours.

Another clearer reaction can be obtained in the following way:—To 20 c.c. of wine 10 c.c. of saturated solution of ammonium alum are added; and next 10 c.c. of sodium carbonate solution, 10 per cent (sp. gr. 1·039), are mixed with it, a dirty greenish precipitate is formed, and by filtration a violet-rose liquid is separated, which gives by spectrum analysis a characteristic band near D, and a hazy absorption in the violet, as follows:—

5892<
5817 |
5775 |
5700<
4860<
4505 |
∞ |

Hollyhock (*Althea rosea*).—When a wine containing some hollyhock is treated by ammonium alum and carbonate of soda, exactly as above, a violet liquid is obtained on filtration that produces the following spectrum:—

6550<
6520 |
6325 |
6150<
5225<
4860 |
∞ |

Portugal Berries (*Phytolacea*) *and Cochineal* can be easily detected by potassium alum and sodium carbonate. To 20 c.c. of wine are successively mixed 10 c.c. of potassium alum solution (10 per cent; sp. gr. 1·053), and 10 c.c. of the above-mentioned solution of carbonate of soda. The mixture passed through a filter gives a limpid and rose liquid, which produces different absorption-bands, according to the substance that is present.

Both phytolacea and cochineal produce these characteristic bands in the same place of the spectrum (viz., from D to *b*), but when the strength of the solutions is appropriate, two bands make appearance with the latter, and only one with the former:—

Portugal Berries.	Cochineal.
5850<	5850<
5625 |	5775 |
5400 |	5667 |
5134<	5562<
	5425<
	5325 |
	5225 |
	5134<

Bilberries (*Myrtille*).—The colouring matter of bilberries is identical with œnolin. I obtained always, and in different ways, perfectly equal reactions with both substances; and I do not think it possible to distinguish one from another. Bilberries, nevertheless, contain citric acid, the presence of which in wine would probably give a means of detecting this colour.

Indigo.—The best method of separating indigo is that indicated by Gauthier. A gelatine solution is mixed with wine; the precipitate formed is thrown on a filter, and washed with water and alcohol; indigo passes through the filter, and a blue colour appears in the washings. This liquid gives a characteristic absorption in the red, as follows:—

6705<
6550 |
6267 |
5362<

I employed in these researches Browning's miniature spectroscope with micrometer, which is a very convenient and complete portable instrument for taking rapidly the position of absorption-bands. Lamplight is preferable to daylight for this purpose, and liquids may be examined through ordinary test-tubes.

Errata.—In my paper on "The Detection of Aniline Colours in Wines," where the absorption-spectra of fucsine with methyl-violet and safranine with methyl-violet are indicated, *instead of* 5586 *read* 6100.

THE PHENOMENON COMMONLY CALLED THE "CRY OF TIN."

By J. C. DOUGLAS.

If a piece of tin be bent it emits a sound; this, being regarded as a property peculiar to tin, has been termed "the cry of tin." This phenomenon is explained by the peculiar crystalline structure of the metal. If the explanation be the true one, then other metals which are obviously crystalline in structure should also exhibit the phenomenon under favourable conditions, but it is exceedingly difficult to place other metals in a crystalline state under proper conditions, *e.g.*, cast-iron and cast-zinc in thin rods break before they can be bent sufficiently to emit audible sounds, while rolled zinc has had its crystalline structure destroyed by rolling, and so is not in a condition to emit sound when bent. Rolled zinc is very tough as compared with cast-zinc, and its fracture is not crystalline, but of an even fine-grained bluish tint destitute of the brilliant lustre presented by this metal in a crystalline state. If, however, a piece of rolled zinc be heated for a few minutes to a temperature somewhat below its melting-point, the metal becomes much less tough, and its fracture is decidedly crystalline. On bending a piece of zinc so treated it emits a sound weaker than, but of the same nature as, the sound emitted by tin. Cast-zinc cannot be bent readily, but if it be pinched between the teeth, or with pliers, it emits the sound distinctly.

It appears, therefore, that the cry of tin is due to crystalline structure, that it is not characteristic of tin as generally accepted, but may be emitted by zinc and probably by other metals when crystalline in texture; that rolling in the case of tin and zinc, and probably in other cases, destroys the property with the alteration of texture; that in the case of zinc which has been rolled, the crystalline texture may be produced without melting the metal, but by merely heating it, and this is so readily done that it affords a ready illustration of the effects of high temperatures on rolled metal. If, as supposed, this sound is characteristic of the crystalline structure of metals, it may afford a means of great practical use whereby, by the sound a metal emits, we may draw conclusions as to its texture, and hence its fitness for certain purposes, or by the sound emitted by a beam when bent we may draw conclusions as to its safety, the microphone or other appliance being called in to aid us where the sounds are exceedingly weak.

Downing College, Cambridge.—Natural Science.—At the College Examination in June, 1881, in addition to the ordinary Foundation Scholarships, open exclusively to members of the College, one Foundation Scholarship of the annual value of £80 will be thrown open to all members of the University who have not kept more than six terms. The subjects of this examination will be, Chemistry (Theoretical and Practical); Physics (Heat, Electricity, and Magnetism); Comparative Anatomy, Physiology, and Botany. The examination for Minor Scholarships, which are open to all persons who have not entered at any College in the University, or who have not resided one entire term in any such College, will be held in Downing College, on Tuesday, the 31st of May next and three following days. Further information will be given by Mr. J. Perkins, or by the Rev. J. C. Saunders, Tutors of the College.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FROM MARCH 21ST TO APRIL 20TH, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

April 21, 1881.

SIR,—We again beg leave to hand you the results of our examinations of the water supplied to the Metropolis for the month ending April 20th.

The circumstances under which the examinations have been made and the precautions taken to secure trustworthy results are similar to those we have described in our previous reports. The samples have been collected from the localities named in our last report.

As regards turbidity and colour a further improvement has taken place in the Metropolitan waters since the date of our last report. Of the 161 samples examined during the month, in 5 only was a trace of suspended matter recognisable.

The method of determining the colour of the water, given in detail in our last report,* has been continued this month on the whole of the samples collected from all the Water Companies. The results are given in Table II. The notation employed having been fully explained last month, need not again be given.

In Table I. we have recorded the analyses in detail of samples, one taken daily between March 21st and April 20th. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

In Table II. is recorded the colour by the method above described, together with the clearness or turbidity of each sample. Of the 161 samples collected by us between the dates mentioned above, 156 were found "*clear*," and 5 were noted as "*very slightly turbid*."

Of the 23 samples supplied by the New River Company, the whole were, without exception, clear, bright, and efficiently filtered.

Of the 23 samples rom the mains of the East London Company, 4 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 23 samples from the mains of the Chelsea Water Company, the whole were bright, clear, and well filtered.

Of the 23 samples from the mains of the West Middlesex Company, the whole were clear, bright, and well filtered.

Of the 23 samples from the mains of the Lambeth Water Company, the whole were clear, bright, and well filtered.

Of the 23 samples from the mains of the Grand Junction Company, the whole were clear, bright, and well filtered.

Of the 23 samples from the mains of the Southwark and Vauxhall Company, one only was noted as "very slightly turbid." The remaining 22 samples were clear, bright, and efficiently filtered.

When a trace of suspended matter is noticeable, we record the water as "turbid." When on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid." A water is recorded as "slightly turbid" when we consider it to come between those two extremes.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen in the whole of the 161 samples collected.

The improvement we had occasion to mention as having taken place in the appearance of the Metropolitan waters in our last report, has been still further noticeable during the past month, and taken as a whole, they leave nothing to be desired in respect of colour, wholesomeness, complete aëration, or absence of suspended matter.—We remain, Sir, your faithful servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

* The composition of the blue solution should be 5 grms. of pure crystallised sulphate of copper in one litre of distilled water, instead of 10 grms. as given last month.

ON A SIMPLE FORM OF APPARATUS FOR DETERMINING THE SPECIFIC HEATS OF SOLIDS AND LIQUIDS WITH SMALL QUANTITIES OF MATERIAL.

By J. W. MALLET, F.R.S.

BOTH of the most trustworthy forms of apparatus hitherto in use for the determination of specific heat—those of Regnault and Bunsen—are somewhat troublesome to prepare for an experiment, the latter notably so. Regnault's calorimeter requires a fresh measurement of the water for each occasion of use, and gives accurate results only with considerable quantities of the materials to be examined,* so that in the case of rare substances, of which but a few grms. can be had it ceases to be available. Bunsen's ice calorimeter, beautiful as the instrument is in principle, and capable of being applied to but a fraction of a grm. of material, can be repeatedly used within a few hours, or at most days, after it has been packed in snow or shaved ice; but when longer set aside, demands, as has been said, no small care and trouble to get it again ready for use.

An arrangement which shall avoid these disadvantages, which shall be simple, and capable of immediate use after having stood aside for weeks or months, which shall work with but little of the material under examination, and which shall give results not necessarily equal in accuracy to the best that may be obtained by more elaborate methods, but accurate enough for the ordinary application to be made by the chemist of a knowledge of specific heat, as bearing on atomic or molecular weight, seems likely to be useful, and may serve to render approximate determinations of this physical constant more frequent, in something the same way that the apparatus of V. Meyer has facilitated the determination of vapour density.

Fig. 1 shows in elevation the general appearance of a little calorimeter which I have found to fairly fulfil these conditions; the figure is from a photograph, and of about one-sixth the linear dimensions of the original. The base, A, and two uprights, B B, are made of hard wood. The cylindrical body, C, of the calorimeter is mounted upon two brass pins, D, passing through the opposite uprights, so that it can be turned round an axis at right angles to its axis of figure. A cross-piece of wood, E, serves to rest the fingers upon in grasping C at the time of use, and elastic bands of india-rubber are stretched across between the uprights to prevent the accidental breaking of the thermometer, F, by violent swinging round of C, from which it projects. An upright arm, G, bears upon it two corks, H I, between which the thermometer moves, and the distance a part of these corks determines the extent of motion of rotation of C during use. The arm, G, itself turns on a pin screwed in to the end of the base, so that it (G) can, when necessary, be turned back out of the way of the thermometer, which can then move further up or down. Two little blocks of wood, K K, respectively in front of and behind the lower end of G, serve as stops to regulate the throwing it into posi-

* Several hundred grms. were used in each of a large number of Regnault's own experiments.

tion or back out of the way as required. A reading lens, L, is arranged upon a cork support to slide upon the stem of the thermometer at a proper distance from its scale, and error of parallax is avoided by a short tube above the lens with a small hole in the upper end to sight through.

Fig. 2 presents a longitudinal section of the body (C in Fig. 1) of the calorimeter of one-half the real linear dimensions. The outer cylinder *a* is a tube of hard india-rubber (vulcanite),* 105 m.m. long by 64 m.m. in diameter inside, 1·5 m.m. thick. The ends are round plates of the same material and thickness, and screw down over the extremities of the tube. The inner cylinder *b* is also a vulcanite tube of the same thickness, 22 m.m. in interior diameter, passing snugly through a simple round hole in one end plate of the outer cylinder and screwing into a corresponding hole in the plate closing the other end.† The space between the inner and outer cylinders is uniformly but loosely filled with delicate turnings of vulcanite. Both ends of *b* are closed by very accurately fitted corks of the finest texture, free from all hard lumps, flaws, cracks, or irregularities of surface. Through one of these corks, *c*, passes the stem of a mercurial thermometer, *d*, specially made for this instrument, the scale bearing centigrade degrees of 6 m.m. long, divided to tenths, and reading easily by estimation to twentieths of a degree, the scale running from 5° to 40° outside the cork.‡ The other cork, *e*, is solid. The length of the inner cylinder, *b*, is divided into two unequal parts by a diaphragm, *f*, of vulcanite of the same thickness with the tube itself, situated 47 m.m. from the end bearing the thermometer, and 59·5 m.m. from the other end. This diaphragm is fixed in its place by three very small screws of vulcanite passing through the wall of the tube, and has in the centre a round hole, *g*, of 7 m.m. in diameter. At three points equidistant from each other round this hole three bits of hard-drawn platinum wire, *h*, each 37 m.m. long and 0·35 m.m. diameter, are firmly inserted on the side next the unperforated cork, their lower ends curved inward and their free ends sprung apart, so that the little platinum cylinder, *i*, when dropped down between them, is grasped firmly enough to retain its place though the tube be inverted, and is supported exactly in the middle of the surrounding space, at equal distances from the inner surface of the tube, from the diaphragm, and from the cork *e*. The platinum cylinder, *i*, intended to contain the substance whose specific heat is to be determined, 28·5 m.m. long by 12·5 m.m. diameter, stiff enough, and slightly drawn in at the open end, so as to be securely closed by the cover, *k*, while the two together weigh only a little over 6 grms. The supporting platinum wires weigh about 0·5 grm. A ring of cork, *l*, 28 m.m. wide and 5 m.m. thick, encircles the outer cylinder, *a*, at the middle of its length, and is itself firmly grasped by a ring of hard wood, *m*, 12·5 m.m. wide and 5 m.m. thick, in which, at two opposite points of the circumference, are the holes *n n*, entered by the brass pins on which the whole turns. A weighed quantity of pure mercury—as I have used the instrument, about 220 grms.—is placed in *b*, and can be shifted from one division of this cylinder to the other through the hole *g*, as by rotation on the bearings, one end or the other is brought uppermost.

* This material was selected on the ground of its remarkably low conducting power, a fact which has been strikingly brought out by the comparative measurements of J. Stefan (*Wien. Acad. Ber.* (2 Abth.), 74, 438-462). He finds, for example, that the true heat-conducting power of vulcanite is several times less than that of ordinary glass, whether considered for equal volumes or equal weights.

† This inner cylinder might with advantage have been made somewhat smaller, brst by shortening both cylinders a little and shifting the diaphragm somewhat toward the end containing the enclosed thermometer.

‡ As the temperature to which the substance to be examined is raised is determined directly from the boiling-point of water under known barometric pressure, the absolute value of the scale of this thermometer, with which the temperature of the mercury in the calorimeter is determined, ought to be known. Comparison with a good standard instrument showed that such errors as exist are too small to sensibly influence the approximate results, which alone can be obtained with the apparatus under notice.

Fig. 3—to same scale as Fig. 1—illustrates the mode of heating, to the temperature of a current of steam, the specimen of material whose specific heat is to be determined. A is a ring, sliding on and fixed at a convenient height on the upright rod of a filter stand, by which the flask B is supported over a lamp. B contains the supply of water for conversion into steam, the steam being carried by the india-rubber tube C into the lower end of the large glass tube D, from the upper end of which it escapes by the india-rubber tube E. The smaller glass tube F, closed at the bottom and placed concentrically within D, serves to contain the little platinum cylinder holding the specimen under examination. A large ring of cork, G, forms a handle, by which D may be taken up without burning the fingers, and during the heating this ring rests on the forked support H. The india-rubber tube, I, carries off water as condensed in D to the glass cylinder, K. The tubes C and I are long enough to allow D to be lifted clear of its support and moved a foot or so without disturbing the rest of the apparatus, and without any interruption of the current of steam through D.

Fig. 4—to a scale of one-half the real linear dimensions—gives a vertical section of the heating-tube (D of Fig. 3) and its appendages. In this figure *a* is the outer glass tube, 145 m.m. long and 45 m.m. inner diameter, closed at top and bottom by corks *b* and *c*. Through the lower cork pass two bits of glass tube, each of 5 m.m. bore, the one connected with the india-rubber tube *d* (C of Fig. 3) for the introduction of steam, the other leading to the tube *e* (I of Fig. 3), also of india-rubber, intended to drain away condensed water. The small bit of glass tube, *f*, also of 5 m.m. bore, passing through the upper cork, leads to the india-rubber tube *g*, about 140 m.m. long, and serves for the escape of uncondensed steam at such a distance as to avoid any risk of either steam or drops of hot water getting into the calorimeter at the moment of transferring to it the platinum cylinder. The inner glass tube, *h*, is 15 m.m. in diameter inside and 107 m.m. long, closed at the lower end, and ground off squarely to a smooth edge at the top. It contains the little platinum cylinder *i*, holding the specimen to be heated. After the introduction of this cylinder a loose plug of carded cotton fibre, *k*, is pushed into the mouth of *h*, which is then closed by a cover or lid formed of a piece of, *l*, with a smooth lower surface, and carefully fitted so as to come down flat upon the mouth of the tube. *l* is attached to the long arm *m* of a little lever of wood, pivoted in a forked support at *n*, and capable of being very rapidly thrown over backward by momentary pressure of the thumb on the short arm *o*, thus completely clearing the mouth of the tube *h*. *l* is weighted by a little piece of lead (a flattened buckshot) of 5 or 6 grms. imbedded in the cork at its junction with *m*. *p* is a large cork ring, 18 m.m. wide and 10 m.m. thick, serving as a handle for *a*, and as a shoulder by which it may rest on the forked support of the stand shown in Fig. 3. An outer jacket of stiff paper, containing cotton fibre or swan's down, may be placed round the glass cylinder *a* during the heating, but this, for the sake of clearness in the figure, is not shown.

The preliminary observations are as follows:—It is first ascertained to what extent the temperature of the mercury in the calorimeter is raised by the metal running down from one end of the inner tube to the other during a given number of turns of the calorimeter on its bearings, the amount of motion in each direction being limited by the distance between the two corks (H and I of Fig. 1) which the thermometer stem touches at the top and bottom of its arc of movement. The rise of temperature is very small, as may be easily calculated from the extent of fall of the mercury, and is diminished by a part of the heat produced being absorbed by the vulcanite, the platinum, and the material of the thermometer. Thus the actually observed rise of temperature was found to be but 0·06° C. for 100 *single* movements of the calorimeter, each transferring the mercury once from end to end of the tube. During this and all other experiments with the calori-

meter it is kept in a large room of as steady temperature as possible and free from strong draughts of air.

The little platinum cylinder (*i* of Fig. 2) is now transferred to the bottom of the inner tube of the heating-apparatus (*h* of Fig. 4), in which it rests upside down, the loose plug of cotton-wool (*k*) is inserted in the mouth of the tube *h*; over this the cork cover (*l*) is brought down, and, the connecting tubes being in position, a lamp is placed under the flask of water, and the water boiled actively, but not so violently as to produce difference of pressure inside and outside the heating tube, thus sending a brisk current of steam steadily through the outer tube for half an hour or an hour, preliminary experiments with a small thermometer in the inner tube having shown that this is time enough to bring the contents of the tube closely up to the true temperature of the steam: the difference of temperature between the steam and the material to be heated was never found to be nearly as great as 1° or 2°, observed by Regnault in his experiments. The barometer and attached thermometer are now read, in order to admit of afterward calculating the true temperature of the steam. A few moments before the platinum cylinder is needed, the plug of cotton is quickly withdrawn, the cork cover dropped back to its place, and the current of steam somewhat increased by raising the lamp flame. The calorimeter, which has previously been kept in a part of the room far enough away from the heating-apparatus not to be sensibly affected by it, is now brought near to it, the thermometer is read and the reading recorded, the arm (G in Fig. 1) thrown back out of the way, the cylinder C—held lightly but firmly with the left hand—is brought nearly upright, with the thermometer downward, the upper cork (*e* of Fig. 2) loosened in its seat with the right hand so that it may be easily taken out, and then held ready for removal with the thumb and first finger of the left hand. The heating tube (D of Fig. 3) is lifted from its support by the cork ring (G), which is placed as in a fork between the second and third fingers of the right hand, the palm of this hand being upward and the thumb lightly resting on the short arm (*o* in Fig. 4) of the little wooden lever which carries the cork cover, *l*. The current of steam is not interrupted while the upper end of the tube (*h* of Fig. 4) is being brought close to the mouth of the calorimeter tube, and then, by quick simultaneous movements with both hands, the cork is momentarily withdrawn from the latter tube, the right thumb is pressed down so as to throw back the cover of the heating tube, and this tube is tilted so as to drop the platinum cylinder down into the calorimeter, where it is held in its central position by the elastic grasp of the three bits of platinum wire. The cork of the open end of the calorimeter is instantly replaced by the finger and thumb of the left hand, and the right hand used to insert it more firmly as soon as the heating tube has been quickly put back upon its support. The calorimeter is now carried back to its place in a distant part of the room, raising as it is carried the thermometer until it is between the two corks of the movable arm, G, this arm being brought forward into position, and the body (C) of the instrument is gently turned* alternately up and down at such a rate as experience has taught will just allow the complete transfer of the mercury from one division of the tube to the other between the reversals, until the thermometer indicates that the maximum temperature due to the introduction of the heated platinum has been reached. A little practice soon teaches one to guess at about the time necessary for this, and the cylinder may then be stopped for a moment to allow of accurate reading, resuming the motion immediately afterward in order to see whether any further rise of temperature occurs. The loss of heat from the vulcanite is so slow that ample time is afforded for accurate observation of the thermometer. As an additional security, however, against the true maximum temperature being overlooked, it is convenient to have a little detached cylinder of mercury in the thermometer tube as an index, like that of the common maximum registering thermometer, but reading from the head of the main column, and using the index merely to assure oneself that the reading is made before the temperature begins to fall. The number of swings made by the calorimeter has been

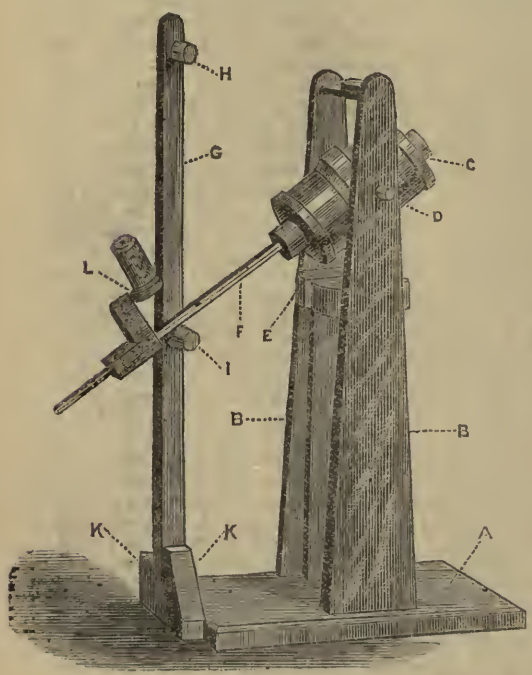

FIG. 1.

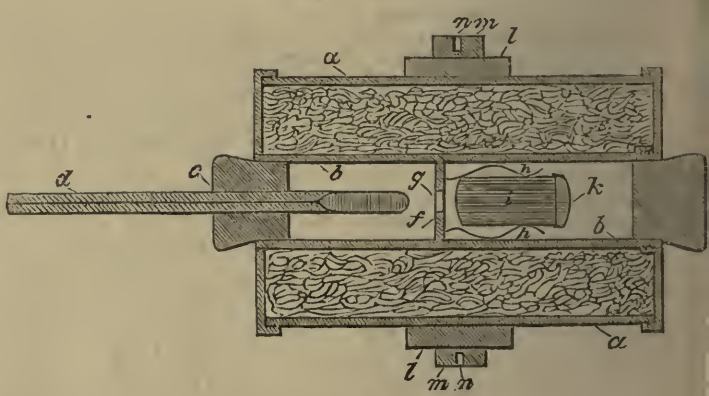

FIG. 2.

* The projecting part of the solid cork *e* is used as a handle.

counted as it was turned. A comparison of the initial temperature of the mercury with that finally reached after the introduction of the platinum cylinder gives the heating effect of the latter plus that due to the agitation of the mercury, as previously determined, for the number of swings made. Subtracting the latter, and after several repetitions of the experiment taking the mean of the results, reduced to the same interval of temperature passed through by the platinum,* the practical effect of the latter in heating the mercury, while itself cooling a given number of degrees, is known.

If now the specific heats of two solid bodies are to be compared, a specimen of each in succession is accurately weighed off, enclosed in the platinum cylinder, raised to the temperature of the steam in the heating apparatus, transferred to the calorimeter, and the effect upon the temperature of the mercury observed, precisely as in the experiment above described with the empty platinum cylinder. Aside from the time occupied in heating up the specimen to be examined, an experiment takes but two or

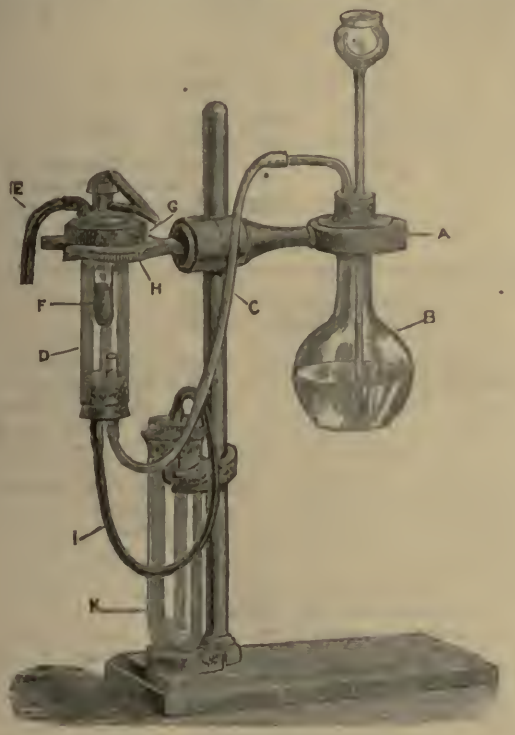

Fig. 3.

three minutes. It is desirable to take such a quantity of the substance as shall occupy the greater part of the capacity of the cylinder, since otherwise, if the platinum cover be not tightly fitted on, a little mercury may be forced into the cylinder in consequence of the contraction of the enclosed air as it cools down. Good results have been obtained, however, with quantities ranging from 0·8 grm. up to 25 grms. From the heating effect produced in the calorimeter in each experiment is to be deducted that due to the platinum cylinder for the interval of temperature passed through, and to the agitation of the mercury for the number of turns made of the body of the instrument. If the second experiment follow immediately after the first there will generally be little difference between the initial temperatures and final temperatures

* The specific heat of platinum, as o f mercury, may of course be considered as uniform within the range o ivariation of the temperatures employed.

respectively of the bodies examined; but of course the results are always to be reduced by calculation to the same interval passed through.

To restore the temperature of the calorimeter quickly after an experiment to that of the room, or very near this, a separate cork is provided, to take the place of *e* in Fig. 2, through which passes a sealed test-tube containing mercury. This mercury is cooled a good deal below atmospheric temperature by immersion of the test-tube for a little while in a larger quantity of mercury contained in a beaker, and either placed out of doors in cold weather or surrounded by ice-water. On inserting the cork in its place at the end of the inner cylinder of the calorimeter, and turning the body of the instrument up and down a few times, the tube of cold mercury reduces the temperature of that which surrounds it until the thermometer reads a little below the temperature of the room. Removing the

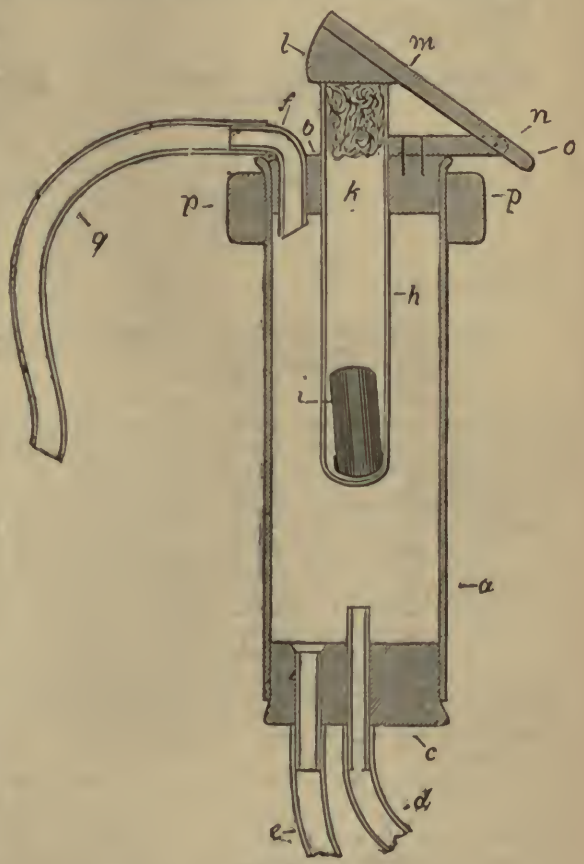

Fig. 4.

cold mercury tube and cork, replacing the latter by the solid cork *e*, turning the end of the calorimeter downwards, taking out the thermometer from the other end, to cool it in like manner by immersion of the bulb in cold mercury, and to set the index, and then replacing it, turning the thermometer end down again, taking out the cork *e*, and allowing the instrument to stand for a little while with the inner cylinder open, the temperature of the room is fully recovered.

In no case is the whole heating effect of the platinum cylinder and its contents expended upon the mercury, a portion of the heat going to raise the temperature of the vulcanite, the end corks, the little platinum wires, and the enclosed portion of the thermometer. But the character and quantity of all these substances sharing in the recep-

A. Substance examined.	B. Substance used for comparison.	C. Specific Heat assumed for Substance in Col. B.*	D. Spec. Heat found for Substance in Col. A.	E. Specific Heat previously recorded for Substance in Col. A.*
Silver	Platinum	0·0323†	0·055	0·057 (Regnault)
			0·058	0·056 (Kopp)
			0·057	0·0559 (Bunsen)
Copper	,,	,,	0·090	0·0951 (Regnault)
			0·098	0·093 (Kopp)
				0·0924 (Wüllner)
Iron	,,	,,	0·110	0·1138 (Regnault)
			0·106	0·112 (Bunsen)
			0·110	
Mercury	,,	,,	0·032	0·0333 (Regnault)
			0·034	0·0337 (Winkelmann)
			0·033	0·0334 (Petersson and Hedelius)
			0·032	
			0·031	
Ferric oxide (specular iron)	Calcium carbonate (Iceland spar)	0·2073‡	0·159	0·1669 (Regnault)
			0·165	0·166 (Neumann)
			0·163	0·154 (Kopp)
Barium sulphate (heavy spar)	,,	,,	0·109	0·1128 (Regnault)
			0·104	0·108 (Kopp)
				0·1088 (Neumann)
Potassium nitrate (cryst.)	Sodium chloride (cryst.)	0·2150§	0·226	0·23875 (Regnault)
			0·238	0·232 (Kopp)
				0·2343 (Neumann)
Cane sugar (cryst.)	,,	,,	0·298	0·301 (Kopp)
			0·292	
Ethyl alcohol	Water	1·0044‖	0·628	0·6769 (calc. from Regnault)
			0·640	0·6138 (Schüller)
			0·637	0·6273 (Dupré and Page, cor. by Schüller's formula)
				0·66885 (calc. from Winkelmann)
Sulphuric acid	,,	,,	0·368	0·343 (Kopp)
			0·355	0·3542 (Pfaundler)

* Where the authorities referred to for the numbers in these columns give the means of ascertaining the specific heat for the particular range of temperature involved in my experiments, this number is quoted.

† 0·0323 (Violle), 0·0324 (Regnault).

‡ 0·2086 (Regnault), 0·206 (Kopp).

§ 0·2140 (Regnault), 0·216 (Kopp).

‖ 1·0039 (Henrichsen), 1·005 (Regnault).

tion of heat being constant, and the circumstances under which heat is given off and received being rendered practically uniform, a large and nearly a constant fraction of the whole heating effect is expended on the mercury, so as to render the results as obtained practically useful measures of the heat given out by the cylinder and its contents. The rate at which heat is taken up from or given off to surrounding matter by the well-protected mercury in the calorimeter is so slow, the greatest difference of temperature which need exist between the interior and exterior is so small, and the time necessary for an experiment is so short,—but two or three minutes,—that the correction employed by Favre for the rate at which the mercury in his calorimeter was heating or cooling from without during an experiment (obtained from observations before and after) need not be, although of course it might be, applied.

The quantity of the substance taken for examination may conveniently be such as to produce a rise of temperature of the mercury to the extent of 5 or 6, or at most 8, degrees, and if the specific heat of the substance can be guessed at, or be roughly determined in a first experiment, greater accuracy may be attained by taking such weights of the substance itself, and of that with which it is to be compared, as shall produce very nearly the same heating effect. If the initial and final temperatures shown by the thermometer be made the same, or nearly the same, in successive experiments, the correction for the portion of the stem outside the calorimeter becomes constant, and so may be neglected in this merely comparative method. Further, instead of comparing the effect in every case with that of a single standard body, I prefer to take for comparison any substance of which the specific heat is already well determined, and whose general character, as regards specific gravity, conducting power, &c., resembles that of the substance of which the specific heat is to be examined, thus using for the purposes of comparison with substances of analogous character such bodies as platinum, mercury, calcareous spar, sodium chloride, water, benzene, &c. The substances compared should be, as far as possible, in the same state of compactness or subdivision. When a liquid is to be examined the specimen is enclosed in a tube of very thin glass, as nearly as possible filling the platinum cylinder, and with a drop of mercury used to close up the greater part of the space round the side and bottom, the heating effect of the kind and weight of glass used being determined beforehand, and the platinum cylinder with its contents weighed on withdrawal from the calorimeter, so as to prove that the little drop of mercury inside has not been increased by any of that in the calorimeter, or diminished by any escaping into the latter. Care is to be taken that in all respects—prevailing atmospheric temperature, quickness of manipulation, &c.—the conditions of comparison be made as nearly as possible the same. This is rendered easy by the short time required for the experiments.

The two main features peculiar to the little calorimeter now described are simply the employment of mercury instead of water as the liquid to be heated, and the comparison, not of the total amounts of heat given out by different bodies in cooling, but of fractions of the same rendered as nearly as possible equal.

The employment of mercury as the material whose temperature is to be raised by the heat given out by the substance experimented on has certain advantages:—1st. For equal bulks mercury experiences 2·2 times the increase of temperature that water does for the same amount of heat received. The volume of mercury used may therefore be made quite small while retaining command of sufficiently accurate reading of the change of temperature produced. 2nd. The superior conductivity of mercury and its low specific heat facilitate the transfer of

heat from the cooling body, shortening the time of the experiment, and thus diminishing the loss of heat through the solid material of the calorimeter, whose properties in the respects mentioned are, as they should be, the reverse of those of the mercury. 3rd. Mercury does not sensibly vapourise at such temperatures as are required for the purpose in question, and hence no loss of heat on this account is to be feared. In experiments like those of Regnault, if made with a small quantity of water in an open vessel, the error due to evaporation, and consequent loss of latent heat, may become considerable, or may require for correction troublesome repetition of weighings of the water used. 4th. For the same reason the original quantity of mercury taken remains unchanged, and hence the instrument is always ready for use. To secure this convenient condition the inner cylinder of the calorimeter is only to be opened with caution, over a little tray of glazed cardboard, and any globules—even the most minute—of mercury which may be found adherent to the corks, thermometer bulb, or cold mercury tube, are to be swept together, as is easily done with a small camel's-hair pencil, and returned to the cylinder.

This application of mercury is to be distinguished from that involved in the calorimeter of Favre and Silbermann, and in that recently described by Prof. Stewart* and Messrs. Gee and Stroud,† in both of which the expansion of mercury in the calorimeter itself is directly measured, and used to determine the rise of temperature.

As regards the second peculiarity of the instrument now described, it is obvious that, in any arrangement for measuring the heat given out from one body in cooling by applying it to raise the temperature of another, it is impossible to prevent loss by conduction and radiation, and by making the vessel of material of high conducting power, and counting it in with its contents, the difficulty is but shifted from the inside to the outside of its walls. On the other hand, it is clearly not necessary that the whole amount of heat given out by the cooling body be obtained in measurable form; it would come to quite the same thing (as far as the determination of specific heats is concerned) if we could secure the measurement in all cases of a constant fraction of it. It is not pretended that this latter result has been fully secured in the apparatus now described, nor is its use proposed as a general substitute for more exact methods, but that it is capable of giving a very fair approximation to such result is, I think, shown by the following examples of determinations of specific heat which have been thus obtained. The figures are not carried in calculation beyond three places of decimals (See Table, page 208).

* *Proc. Manchester Lit. and Philos. Soc.*, March 4, 1879.
† *L., E., and D. Philos. Mag.*, Sept., 1880, p. 171.

CORRESPONDENCE.

THE ESTIMATION OF PHOSPHORUS IN STEEL.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 186, there appears a criticism of my paper on the estimation of phosphorus in steel by a correspondent who signs himself "Phosphorus." If "Phosphorus" would explain what there is "astonishing" about the "device" of introducing a known amount of pyro-phosphate, and re-estimating it, I should be glad.

The salt was added to the dry oxide obtained from the first evaporation, and was dissolved in concentrated HCl, so that any speculation your correspondent may have indulged in as to its ultimate conversion to ortho-phosphate was unnecessary, as under the circumstances it would undoubtedly be converted into the normal phosphate.

"Phosphorus" refrains from "going into detail," and contents himself with the vague statement that my results are almost all open to exception." He then proceeds to sum up my errors in the manipulation of the molybdate process under three heads.

In the first he takes exception to the term "moderate excess," and perhaps the words are somewhat ambiguous, as indeed are the words "very *large* excess." However, I can soon dispose of the first count in the indictment by informing "Phosphorus" that the amount of strong molybdate reagent used throughout the experiments was 50 c.c., an amount which all will admit to be ample.

"Phosphorus" next points out that the molybdate process when carried out in the presence of chlorides (which is very often the case in a rapid estimation, the solution being evaporated only once with HNO_3), is not reliable. "Phosphorus" speaks of evaporating to low bulks "several times," as though any consideration of time was quite out of the question. This same indifference is exhibited in count three, where he speaks of a "much longer time" than two hours being necessary. The allowance of time "Phosphorus" regards as one of "the most important conditions of success," and then in his next words he admits that in the presence of a "hastener" this condition is neglected. Did "Phosphorus" notice that in subsequent experiments I tried the molybdate process under every possible condition, and with all the precautions he states I neglected? Did "Phosphorus" observe that I pointed out that the results obtained by getting rid of chlorides (in a shorter and more effectual way than by mere evaporation with HNO_3), were higher than the results obtained when the process was carried out hurriedly? If the molybdate process be carried out with all precautions it is still low, and occupies a much longer time than the modified method. If it is carried out in a hurried manner the results are obtained quickly, but are of little value. Further experience with the modified process has shown that it can be carried out as quickly as the rapid molybdate method, as the precipitate may be filtered off in less than an hour, after adding the magnesia salt.

"Phosphorus" assumes that I get down the correct weight of the definite salt of phosphorus, and convert it into the magnesia salt, whereas I distinctly stated that in order to get down the whole of the phosphoric acid, the solution was boiled, and free molybdic acid was obtained in addition to the phospho-molybdate, and that it is to get rid of the MoO_3 the phosphorus is re-precipitated with magnesia. If it can be proved that the *whole* of the H_3PO_4 can be precipitated as phospho-molybdate without bringing down free molybdic acid (which I hold as most uncertain), then undoubtedly it is preferable to weigh as yellow salt on account of the small amount of phosphorus it contains, though at the same time it is a troublesome precipitate to deal with compared with the pyro-phosphate. Again, if it can be shown (and I maintain it to be the case) that in spite of the advantage of the molybdate precipitate compared with the magnesia precipitate in point of the percentage of phosphorus, the molybdate yields low results, the fact becomes a powerful argument against the process.

—I am, &c.,

J. Oliver Arnold.

Sheffield, April 28, 1880.

METHOD OF TESTING THE VALUE OF INSOLUBLE PHOSPHATES.

To the Editor of the Chemical News.

Sir,—Of all the curious methods which have been proposed for determining by chemical processes the commercial value of natural or manufactured substances, none seem to me more strange and unsuitable than the method of testing the value of insoluble phosphates, whether reverted or not, in superphosphate by means of citric acid. These insoluble phosphates will not come under the influence of citric acid in the soil, and therefore their solubility in that acid can be no proper test of their industrial value.

A much more natural plan would be to determine their

solubility in a solution of definite strength of ammonic sulphate or chloride, or one of sodic chloride. A good many years ago one of my evening students determined the relative solubility of the insoluble phosphates in different manurial substances in solutions of sodic chloride and salts of ammonia of different strengths, and his investigation proved that when tested by what may be termed one of these natural processes, these phosphates have different industrial values.—I am, &c.,

ROBERT GALLOWAY.

Dublin, May, 1881.

BENZOL TESTING.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xliii., p. 186, appears a letter from Mr. W. W. Staveley, in which he accuses me of unjustly criticising his previous letter. He gives an example of that unjust criticism thus: It is not fair to say simply "that he obtained 37 per cent of distillate from a 30 per cent benzol when the temperature did not rise above 97° C.," but it would, according to Mr. Staveley, be fair if I had added that the experiment was made in an apparatus similar to the one suggested by me in my first letter, and that it took one and a half hours for the distillate to come over. If these points had been of importance to the question at issue, they would have been mentioned, but they are not. Mr. Staveley, as a "specialist," has the idea deeply impressed on his mind that time and kind of apparatus are important factors in benzol testing. He says he ought to know all about benzol testing, because he has had many years experience in a large benzol refinery. I do not wish to reflect upon the intelligence of Mr. Staveley when I say that the same argument would prove that an experienced navvy should be an excellent engineer. But Mr. Staveley no sooner relies upon the value of his experience than he shows that it does not mean much, for he now acknowledges that "J. D." (the gentleman he ridiculed in his previous letter) has taught him something, and he is now pleased to reconsider the process as a whole which a short time ago he regarded as infallible.

The question of lengths of thermometer bulbs is of no importance. In my criticism of Mr. Staveley's letter I cited it as an example of his rhetoric. He does not deny that thermometers are commonly sold and used, the bulbs of which vary from ⅛ths to 1 inch or more in length, which he acknowledges to be a great difference, but he does deny that persons testing benzols throughout the country use thermometers, the bulbs of which vary materially in length; thus we have a combination of three extraordinary circumstances. First, that there is a divinity which must have told benzol testers what lengths the bulbs of their thermometers ought to be. Second, that Mr. Staveley has the extensive acquaintance of most of the persons throughout the country who test benzols; and third, that, if the second be granted, he is a man of extraordinarily acute observation, and possesses a marvellous memory that he should, without having any object for doing so, *observe* and *remember* the sizes of the bulbs of the thermometers of his numerous friends.

If open Bunsen flames be used in benzol testing, independently of the form of apparatus employed, it will be next to impossible for two persons, testing the same sample (especially if they don't know previously what, according to Mr. Staveley, it *ought to give*), to obtain the same result. The test is made by applying an open flame to the apparatus containing, say, 100 c.c. of the sample, and the temperature is allowed gradually to rise to 100° C., when the flame is withdrawn and the distillate measured. It would doubtless be unfair criticism, to Mr. Staveley's mind, if I did not mention that the distillate should fall in drops from the end of the condenser. There are, however, big drops and little drops, and perhaps the committee which Mr. Staveley and "J. D." propose to consider the process, would stipulate among other things for the diameter of the drop; but, with an open flame, and attending to the "necessary" precautions as nearly as possible, I find I can make the temperature gradually reach 100° C., and only bring off 20 per cent of distillate; or I can arrange the size of the flame so that 50 per cent comes over by the time the temperature reaches 100°, and I will therefore credit Mr. Staveley with being a man of observation when he implies in his last letter that time and kind of apparatus *are* important factors in his method of benzol testing, and I trust he will not consider that I criticise unfairly when I add that *consequently* the process is a stupid one.

Let an absolutely constant source of heat be applied to the retort, and let the height of the barometer be taken into account, and then, and not till then, will the process stand upon a reasonable basis, and then the questions of sizes of condenser and retort, thickness of glass, numbers of drops falling per minute, &c., may be disregarded without seriously interfering with the result. A standard temperature may be obtained by heating the retort with a boiling solution of common salt of a specified density in an apparatus such as that figured in my first letter, taking away the flame used for boiling, the moment the thermometer in the retort indicates 100° C.; or by using the same apparatus as an air-bath, regulating the temperature at, say, 140° C. by an apparatus, which may be bought, and which will keep the temperature constant by regulating the size of the flame which acts as the source of heat. I may add that by distilling benzol with an open flame, taking away the lamp when the temperature rose nearly to 100° C., and applying it again and again as the temperature fell, I got precisely the same result, only with much care and trouble, as that which was obtained by distilling by the heat of a boiling solution of salt with little care or attention.—I am, &c.,

WILLIAM THOMSON.

Manchester, April 30, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 13, December 9, 1880.

Experiments on the Discharge in Rarefied Gases.—A. Righi.—The cause of the mechanical action peculiar to the negative electrode in a Crookes tube illuminated by a Ruhmkorff coil is the same as in the radiometer. The electric force of the negative electrode acting upon the molecules which depart from it charged negatively, tends to give them a direction normal to the surface of the electrode itself. When these molecules come in collision with the glass they discharge themselves, and the glass becomes luminous. We often see, in fact, discharges passing from the positive electrode to the fluorescent portions of the glass.

No. 14, December 16, 1880.

The Constitution of Benzol.—M. Gerber.—The six carbon atoms of benzol are mutually linked together by nine simple bonds, and the formula which admits three simple and three double bonds must be abandoned as not in harmony with facts.

No. 15, December 23, 1880.

Detection of Starch in Milk.—M. Hager.—The lacto-proteic bodies combine rapidly with free iodine and decolourise the solution. Iodine is therefore added till the milk appears yellow, the mixture is stirred, and after waiting till the yellowness has disappeared more iodine is

added till either the yellow colour becomes permanent, or the colouration of iodide of starch makes its appearance

On Spectroscopy.—Dr. L. Ciamician.—The following are the results of the examination of the spectra of certain compounds and of twenty elementary bodies:—Carbon, like other elements, has a spectrum of the first and another of the second order. Cyanogen, carbon oxide, and acetylene are the only carbon compounds having a special peculiar spectrum. The spectra of cyanogen and of carbonyl have a simple relation to those of their components of the first order. The more refrangible side of the spectra of cyanogen and of carbon oxide is homologous to the same side of the spectrum of the first order of carbon, and the less refrangible half of the spectrum of cyanogen is comparable to that of the spectrum of the first order of nitrogen. The spectra of the first order of carbon, boron, silica, and aluminium are mutually homologous. Still, the less refrangible side of the spectra of silicon and aluminium has no corresponding part in those of carbon and boron, and might be compared to the less refrangible region of the spectra of the elements of the oxygen group. Boron, silicon, and aluminium have spectra of the first order corresponding to that of carbon. The spectra of the first and second order of carbon and magnesium are respectively perfectly homologous. The more refrangible part of the homologous spectra of barium, strontium, and calcium is homologous with the spectrum of magnesium. The spectra of oxygen, sulphur, selenium, and tellurium are perfectly homologous among themselves, both in the more and the less refrangible portion. The spectra of phosphorus, arsenic, and antimony are only comparable with those of nitrogen as regards the red portion. The spectra of the halogens and that of fluorine are homologous only as regards their less refrangible portion. The less refrangible part of the spectra of silicon, aluminium, calcium, strontium, and barium is homologous to the same portion of the spectra of the oxygen group. The elements which are best comparable are those placed in a horizontal series in the tables of M. Mendelejeff. These are: Sulphur, silicon, aluminium, calcium, selenium, strontium, tellurium, and barium. The more refrangible parts of the spectra of chlorine, bromine, iodine, phosphorus, arsenic, and antimony are homologues of the more refrangible parts of the spectra of the elements of the oxygen group. The spectra which are best comparable in this respect are those of sulphur, chlorine, phosphorus, selenium, arsenic, tellurium, iodine, and antimony. The relations of homology of the elements as just explained, and the homology of the spectra of cyanogen and carbon oxide with those of their component elements, lead to the supposition that the homology of the spectra of the elements has its ground in their mode of composition. This view, taken in conjunction with the regularities of atomic weights as detected by M. Mendelejeff, gives rise to the following conclusions:—The spectra of carbon, boron, and magnesium, are perfectly homologous among themselves. These three elements are therefore composed of equal matter in different states of condensation, which are manifested by the displacement of the homologous lines. The atomic weights of carbon and boron differ very little; that of magnesium is $24=2\times12$. The spectra of silicon and carbon are respectively homologous, the more refrangible side corresponding to the spectrum of carbon, and the less refrangible side to that of oxygen. Silicon is therefore a compound of carbon and oxygen conformably to its atomic weight, $28=12+16$. Aluminium contains carbon under the form of boron (perhaps under that of glucinum), as indicated by its atomic weight, $27=11+16$, this carbon being combined with oxygen. The metallic elements of the group of alkaline earths produce spectra, the more refrangible part of which corresponds to the spectrum of magnesium, and the less refrangible part to those of the elements of the oxygen series. Consequently, calcium, strontium, and barium are composed of carbon under the form of magnesium and oxygen under the condensation-forms of sulphur, selenium, and tellurium, according to their atomic weights (calcium $= 24+16$, strontium $= 24+4\times16$, barium $= 24+7\times16$). The elements of the oxygen group are composed of one and the same matter in different states of condensation, manifested by the displacement of the groups of the homologous lines of their spectra. The atomic weights of the elements of this series are:—Oxygen $=16$, sulphur $=16+1\times16$, selenium $=16+4\times16$, tellurium $=16+7\times16$. The halogens are all composed of fluorine and oxygen in different states of condensation, as shown by their atomic weights:—chlorine $=19+16$, bromine $=19+4\times16$, iodine $=19+7\times16$. The spectra of the elements of the nitrogen group are homologues, in their less refrangible part of that of nitrogen, and in their more refrangible part of those of the oxygen group. These elements are consequently compounds of nitrogen and of oxygen more or less condensed, as appears from their atomic weights:—Nitrogen $=14$, phosphorus $=14+16$, arsenic $=14+4\times16$, antimony $=14+7\times16$.—*Ber. Kaiser. Akademie der Wissenschaft. Wien.*

No. 16, December 30, 1880.

Soap of Molasses.—M. Junemann proposes to manufacture an improved soap by dissolving 28 parts soda-ash in 100 parts molasses, and stirring in 100 parts of oleic acid.

MISCELLANEOUS.

South London School of Pharmacy.—The prizes were awarded to the following successful competitors at the examinations ending the Second (B) Course, and presented on April 30, 1881:—Senior Chemistry, Medal, Mr. Thomas; Junior Chemistry, Medal, Mr. Shaw; Botany, Medal, Mr. Bull; Pharmacy, Medal, Mr. Walker; Materia Medica, Medal, Mr. Kay.

The Native Guano Co.—At the Norwich Fisheries Exhibition a prize of £20 and a silver medal were awarded to the Native Guano Company, Limited, for their success in purifying sewage and other polluted water so as to be innocuous to fish. Some small model tanks were exhibited with fish living in the purified water. The public and the local press seem struck with the necessity of applying this process (A B C process, Sillar's patent) to the treatment of town sewage, which is discharged into fishing-streams.

MEETINGS FOR THE WEEK.

MONDAY, 9th.—Royal Institution. General Monthly Meeting, 5.
—— Royal Geographical, 8.30.
—— Society of Arts, 8. "The Art of Lace-Making," Alan S. Cole.
TUESDAY, 10th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.
—— Society of Arts, 8. "Trade Relations between Great Britain and Her Dependencies," William Westgarth.
WEDNESDAY, 11th.—Society of Arts, 8. "The Manufacture of Glass for Decorative Purposes," H. J. Powell (Whitefriars Glass Works).
—— Microscopical, 8.
—— Geological, 8.
THURSDAY, 12th.—Royal, 4.30.
—— Royal Institution, 3. "Magnetism," Professor Tyndall.
—— Society of Arts, 8. "Recent Progress in the Manufacture and Application of Steel," Professor A. K. Huntington.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
FRIDAY, 13th.—Royal Institution, 8. "Mental Images and Vision," Mr. F. Galton, 9.
—— Society of Arts, 8. "Burmah," General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.
SATURDAY, 14th.—Royal Institution, 3. "Scotland's Part in English Literature," Prof. Morley.
—— Physical, 3.

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Alumina	59·00	53·83	52·00
Peroxide of Iron	0·47	1·57	4·57
Silica	18·00	8·67	12·00
Titanic Acid		5·80	6·20
Lime, Magnesia, Potash, Soda, and Sulphuric Acid	0·23	0·83	1·14
Combined Water	22·30	29·27	24·00
	100·00	99·97	99·91

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THE CHEMICAL NEWS.

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NOTES ON THE OXIDES OF MANGANESE.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon, F.C.S., Assistant Master at Highgate School.

(Continued from p. 202.)

§ VI. *Discussion of results.*

THE examination of the results recorded in the preceding tables would at first sight lead to the conclusion that the circumstances influencing the behaviour of manganese oxides on being heated remain so far without elucidation. By collecting, however, the substance of these various tables into another single table (VI.), and inserting a column giving the amount of water present in each sample, we bring into prominence a factor which, though it may not entirely determine the results, has at any rate a considerable influence on the behaviour of these oxides. Their behaviour at 100° C., this being the only temperature at which experiments were made in every case, is alone dealt with here.

First of all, it is at once apparent that the amount of the loss or gain of oxygen does not depend entirely on the richness of the oxide experimented on. In the case of the impure oxides, for example (Nos. 1, 2, and 3), the richest specimen absorbs a considerable amount of oxygen, while the poorest, which only contains half the percentage of dioxide, remains absolutely unchanged, and the oxide of intermediate composition absorbs no oxygen, but on the contrary evolves some.* This last-mentioned oxide is also found to undergo nearly the same amount of alteration as one containing double the percentage of dioxide. Taking, again, the pure and dried dioxide (Nos. 4, 5, and 6), we can trace absolutely no relation between the amount of the loss and the oxygen value of the oxide, while with the two pure and undried oxides (Nos. 4 and 8) the amount of the loss varies with the richness of the sample, a small increase in the percentage of dioxide present increasing this loss more than threefold. From these facts it follows that on taking oxides of various composition, and heating them for any length of time at a given temperature between 100° and 200° they will not eventually attain the same composition.

Now on comparing the change effected by heat on the oxides with the amount of water contained in them before heating, we find that, with the first three specimens, the same order attains in both cases, and that when the oxide used is nearly anhydrous no alteration at all takes place. With the next three oxides this does not quite hold good, either No. 5 or No. 6 appearing to be exceptional; but either of these, when taken separately and compared with No. 4, conform to this rule. The last two oxides given in the Table can scarcely be considered in reference to this point, since from the very large amount of water they both contain it is probable that we are dealing with the highest hydrate possible in each case.

The relationship above indicated, although it is the only explanation which can be suggested to explain the results obtained with No. III. as compared with those obtained with No. I.,† is, however, not universal, and might be accidental were it not for the stronger evidence brought forward in favour of this view by the experiments described in the next section.

* Instead of a loss of 0·665 per cent of the dioxide, perhaps a gain of 0·9 per cent should have been recorded. (See § VIII.)

† The oxide No. 3 was prepared from No. 1 by ignition. (See § III.)

TABLE VI.

Showing the Relationship between the Loss or Gain of Oxygen at 100° C. and the Composition of the Oxide.

Oxide.	Ratio of Mn as MnO_2 to Mn as MnO.	Percentage Mn present as MnO_2. Total Mn present = 100.	Percentage of Water present before heating.	Percentage Alteration in the MnO_2 found.
No. 1 (See Table I.)	1·901 : 1	65·53	19·683	1·37 p.c. gain
No. 2 (See Table II.)	0·748 : 1	42·79	3·936	0·665 p.c. loss
No. 3 (See Table III.)	0·494 : 1	33·07	1·050	No alteration.
No. 4 (See Table IV.)	6·014 : 1	85·75	30·113	2·458 p.c. loss
No. 5 (See Table IV.)	6·239 : 1	86·17	21·293	0·682 p.c. loss
No. 6 (See Table IV.)	7·423 : 1	88·13	5·49	1·065 p.c. loss
No. 4 (See Table V.)	6·014 : 1	85·74	95·342	2·657 p.c. loss
No. 8 (See Table V.)	7·270 : 1	87·91	85·422	8·530 p.c. loss

§ VII. *Experiments showing the Alteration Produced by Heating to Depend on the Loss of Water.*

1. *Case in which an Absorption of Oxygen takes place.*—The only one of the above-mentioned oxides which was rendered richer by heating was No. 1, and consequently all the experiments given in the next table refer to this oxide.

The first experiments, made in order to ascertain whether the loss of water influenced the alteration in the oxide, were obviously to heat the oxide in such a manner that all loss of water should be prevented. This was effected in experiments 104 and 105 by actually keeping a weighed portion of the oxide in boiling water for two hours. The mean of the results thus obtained are remarkably concordant with the determinations made before heating at all, and show that no change whatever had taken place during the ebullition. It would, of course, hardly have been expected that any absorption of oxygen could have taken place from a medium containing so little of that gas as boiling water does; but this same circumstance which would prevent the absorption of oxygen by the oxide would have proportionately facilitated the evolution, and if we had found the oxide to become poorer in dioxide by this treatment, we should have concluded it probable that this oxide was a mixture of two oxides, one of which, on being heated at 100° C., absorbed oxygen, while the other at the same time lost oxygen. As it is, however, no such conclusion can be drawn.

The next experiments made on this subject (Experiments 106 to 111 in the Table) consisted in increasing the amount of water evolved by the oxide without raising the temperature, and seeing whether this produced a proportional increase in the absorption of oxygen. In order to effect this, samples of the oxide were heated for some time at 100° in the air-bath as usual, and then moistened and again re-heated, the moistening being repeated at intervals of about half or one hour. The increase in the amount of oxygen absorbed which is produced by this treatment is very remarkable: when moistened and heated twice the gain is more than three times as great as when not moistened at all, and the increase produced goes on augmenting in value with the number of times the oxide is moistened, till in the last experiment, where the moistening had been repeated nineteen times, it amounts to 9·56 per cent, or about 7 times that observed in experiments 9, &c.

In experiments 112 to 115 samples of the oxide in a porcelain boat were placed in a tube passing horizontally

through a large steam-bath. In 112 and 113 a current of the laboratory air was drawn through the tube, and this was nearly saturated with moisture at 14° C., and hence its hygrometric state at 100° C. would be about 1-60th. In the next two experiments the air was carefully dried, and this fact of the air being dry, and therefore capable of abstracting a great amount of moisture from the oxide, caused the increase in dioxide found to be raised from 1·35 to 6·75 per cent. The amount of water lost in each case was approximately determined, and is given in the table. In every case the heating was continued until the oxide became constant in composition.

The experiments Nos. 112 to 115 in this Table, as well as Nos. 73 to 77 in Table IV., and Nos. 116 to 122 in Table VIII., were performed more recently than the others, and in them the temperature of 100° C. was accurately attained by the use of a steam-bath; and on comparing the results of Nos. 112 and 113 with the similar ones in Table I. (Nos. 9 to 14) we find that the increase recorded is nearly identical, which fact would lead us to conclude that the temperatures observed in the earlier experiments with an air-bath express the truth with considerable accuracy.

TABLE VII.

Experiments showing the Absorption of Oxygen to depend on the Loss of Water.

Oxide No. 1 used.

Conditions of Experiment.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Increase in the MnO_2 present.
Before heating—			
1. (See Table I.)	55·396		
After heating—			
9. At 100° C. in an air-bath (See Table I.)	56·152		1·37
104. After being kept in boiling water for 2 hours	55·297	55·393	none
105. Ditto ditto	55·489		
Heated at 100° C.—			
106. For 1¾ hrs., during which moistened twice	57·773		4·29
107. For 5¼ hrs., ditto, 4 times	58·454		5·52
108. For 6¼ hrs., ditto, 5 ,,	58·797		6·14
109. For 6¼ hrs., ditto, 6 ,,	59·672	59·689	7·75
110. For 6¼ hrs., ditto, 6 ,,	59·706		
111. For 21½ hrs., ditto, 19 ,,	60·692		9·56
Heated at 100° C.—			
112. In a steam-bath in moist air. Lost 11·02 p.c. Aq	56·246	56·157	1·35
113. Ditto, ditto 10·78 ,,	56·068		
114. Do., dry air 12·80 ,,	59·016	52·203	6·75
115. Ditto, ditto 13·70 ,,	59·390		

2. *Cases in which an Evolution of Oxygen occurs.*—The oxide which was selected for these experiments was unfortunately one of the pure oxides which underwent least change on being heated, and hence the differences observed in the various cases are not so marked as they might have been had one of the other specimens been used.

The first experiments on the subject were made by boiling weighed quantities of the oxide in water for various lengths of time (Experiments 116 to 118, Table VIII). Contrary to what had been expected, a change is effected by this treatment, which change is complete in two-and-a-half hours, but not in an hour-and-a-half. The loss in oxygen under these circumstances is, indeed, greater than when the oxide is heated in air. Hence it appears that any hindrance to the loss of oxygen which may be made by preventing a loss of water has been more than counterbalanced by the facilities offered for this loss by the presence of a boiling liquid, as indicated above. These experiments, therefore, afford us no evidence in favour of our theory, but, on the contrary, show that even when (probably) no loss takes place* an evolution of oxygen may still be made to occur. The next experiments, however, prove satisfactorily that the loss of water is an important factor in determining the loss of oxygen. They consist, like some of the experiments in the previous table, of heating the oxide at 100° C. in moist and in dry air; and we find that here, as on the former occasions, the use of dry air increases the amount of change, the loss being nearly twice as great as when moist air is used.

TABLE VIII.

Experiments showing the Evolution of Oxygen to depend on the Loss of Water.

Oxide No. 5 used.

Conditions of Experiment.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Diminution in the MnO_2 found.
Before heating—			
73. (See Table IV.)	69·618		
After heating—			
75. At 100° in air (Table IV.)	69·143		0·682
Kept in boiling water—			
116. For 1½ hours..	69·804		
117. For 2½ hours..	68·639	68·750	1·247
118. For 4 hours..	68·862		
Before heating—			
73. (See Table IV.)	69·618		
After heating at 100° in a steam-bath in moist air—			
119. For 1½ hours..	69·407		
75. For 2½ hours..	69·053	69·143	0·682
76. For 3½ hours..	69·204		
77. For 4 hours..	69·131		
In dry air at 100° C.—			
120. For 1½ hours..	69·558		
121. For 2 hours..	68·815	68·798	1·178
122. For 3 hours..	68·780		

(To be continued.)

DYEING REDS WITH ARTIFICIAL ALIZARIN.

By M. MAURICE PRUD'HOMME.

SINCE several years, the methods of madder dyeing have undergone a complete revolution, the origin of which we will seek to point out. When artificial alizarin, thanks to the beautiful researches of Graebe and Liebermann, made its industrial appearance in 1869, it was soon found that the commercial product, though yielding beautiful purples, was incapable of producing brilliant reds (C. Kœchlin). Whilst admitting that the new product was identical with the alizarin extracted from madder, we were led to conclude that in order to produce fine Turkey reds, the colouring matters which accompany alizarin must play an important part. This was the idea propounded by Kuhlmann as far back as 1828 (*Soc. Ind. de Mulhouse*, 49, p. 86). According to the researches of MM. Schützenberger and Schiffert, the colouring matters of madder are alizarin, purpurin, pseudopurpurpurin, purpuroxanthin, and an orange matter, which M. Rosenstiehl considers identical with hydrated purpurin. Subsequently, there have been added to the list an orange body, purpuroxantho-carbonic acid of Schunck and Roemer, identical with the munjistin found by Stenhouse in the madder of India. It was known that purpuroxanthin does not dye; that pseudopurpurin is very easily transformed into purpurin, and the uncertainty which was felt concerning hydrated purpurin left room

* Even, here, however, a loss of water may have occurred. It is not at all contrary to general experience that a highly hydrated substance which has been prepared in the cold should become partially dehydrated at 100° C., even though immersed in water.

merely for the hypothesis that Turkey-red is obtained by the concurrent action of alizarin and purpurin. In the meantime, the manufacture of artificial alizarin became extended, and a compound was sold as "alizarin for reds." It is now known, thanks to the researches of Perkin, Schunck, Roemer, Graebe, and Liebermann, that in the manufacture of artificial alizarin there are produced three distinct colouring matters—alizarin, iso- or anthra-purpurin, and flavopurpurin, the two latter being isomers of purpurin. We may remark that purpurin has not been obtained by direct synthesis. M. de Lalande has produced it by the oxidation of alizarin. Alizarin is derived from mono-sulph-anthra-quinonic acid, on melting with the hydrate of potassa or soda. It is a dioxy-anthraquinone.

Anthra-purpurin and flavo-purpurin are obtained from two isomeric disulph-anthraquinonic acids, improperly named iso-anthraflavic and anthraflavic acids, which are converted into anthrapurpurin and flavopurpurin by a more profound action of potassa. These two bodies are trioxy-anthraquinones.

We call to mind that alizarin dyes reds of a violet tone, free from yellow; roses with a blue cast and beautiful purples. Anthrapurpurin and flavopurpurin differ little from each other, though the shades dyed with the latter are more yellow. The reds produced with these colouring matters have a very bright yellowish reflection, but the roses are too yellow and the purples incline to a dull grey.

Experience with the madder colours shows that a mixture of alizarin and purpurin yields the most beautiful roses in the steam style, but it is not the same in dyeing, where the roses got with fleur de garance have never been equalled. A mixture of alizarin and of anthra- or flavo-purpurin is not a perfect substitute for alizarin and purpurin. In practice the three sulph-anthraquinonic acids, the generators of the three colouring matters, are easily separated by varying the concentration and the quantity of the sulphuric acid employed, and by taking advantage of the different solubility of the salts of each.

"Alizarins for reds" all contain more or less of alizarin properly so-called, from 1 to 10 per cent, along with anthra-purpurin and flavopurpurin. This proportion does not affect the tone of the reds obtained further than by preventing them by having too yellow a tone.

The first use of the alizarins for reds was for application of styles, that is colours containing at once the mordant and the colouring matter and fixed upon the cloth by the action of steam. Good steam-reds were easily obtained by using receipts originally designed for extracts of madder (mixtures of alizarin and purpurin). On the other hand, the first attempts at dyeing red grounds and red pieces were not successful. The custom of dyeing up to a brown with fleur and then lightening the shade by a succession of soapings and cleanings had much to do with this failure. Goods, mordanted with alumina and dyed with alizarin for reds up to saturation, never reach the brown tone given by fleur or garancin. This tone is due in great part to the presence of fawn-coloured matters, which the cleanings and soapings served to destroy or remove. The same operations have also another end—to transform the purpurin into its hydrate, which is brighter and more solid. The shade, in a word, loses in depth and gains in brightness. With alizarins for reds, the case is quite different; they contain no impurities to remove and no bodies which may gain brightness in consequence of chemical changes under the influence of the clearings and soapings. These have only one result, in addition to the formation of a lake of fatty acid, that is to make the shades lose in intensity. The method of subjecting reds got up with alizarin to the same treatment as madder-reds was faulty.

There appeared next a method of dyeing bases upon different principles. The work of M. Schützenberger (1864) speaks of the use of sulpho-conjugated fatty acids for the fixation of aniline colours. In England, for a number of years, dyed-reds had been padded in soap-baths and afterwards steamed to brighten the red. In 1867, Braun and Cordier, of Rouen, exhibited Turkey reds dyed in five days. The pieces were passed through aluminate of soda at 18° B., then through ammonium chloride, washed, dyed with garancin, taken through an oil-bath dried and steamed for an hour, and were finally cleared in the ordinary manner for Turkey-reds. The oil-bath was prepared by treating olive-oil with nitric acid. This preparation, invented by Hirn, was applied since 1846 by Braun (Braun and Cordier). Since 1849, Gros, Roman, and Marozeau, of Wesserling, printed fine furniture styles by block upon pieces previously taken through sulpholeic acid. When the pieces were steamed and washed the reds and roses were superior to the old dyed reds and roses produced at the cost of many sourings and soapings. Certain makers of aniline colours sold mixtures ready prepared for printing which were known to contain sulph-oleic acids. There was thus an idea in the air that sulph-oleic acid, under the influence of steam, formed brilliant and solid lakes with colouring matters. These facts detract in nothing from the merit of M. Horace Kœchlin, who combined these scattered data into a true discovery. The original process may be summed up under the following heads:—Printing or padding with an aluminous mordant, which is fixed and cleaned in the usual manner; dyeing in alizarin for reds with addition of calcium acetate; padding in sulpholeic acid and drying; steaming and soaping. The process was next introduced into England, whence it returned with the following modifications: in place of olive-oil or oleic acid, castor oil was used, as cheaper, and the number of operations was reduced. Castor oil, modified by sulphuric acid, can be introduced at once into the dye-beck, so that the fixation of the colouring matter as the lake of a fatty acid is effected in a single operation. The dyeing was then followed by steaming and soaping.

For red on white grounds and for red grounds, a mordant of red liquor at 5° to 6° B. is printed on, with a little salt of tin or nitro-muriate of tin. It is fixed by oxidation at 30° to 35° C., and dunged with cow-dung and chalk. The pieces are then dyed with 1 part alizarin for reds at 10 per cent, ¾ to ¼ oil for reds (containing 50 per cent), 1-6th part acetate of lime at 15° B., giving an hour at 70° and half an hour at the same heat. Wash, pad in oil (50 to 100 grms. per litre of water), dry on the drum, or better in the hot flue, and steam for three-quarters to an hour and a half. The padding in oil is needless, if sufficient oil has been used in dyeing, and the pieces may be at once dried and steamed. Wash and soap for three-quarters of an hour at 60°. Give a second soaping if necessary. If there is no fear of soiling the whites, dye at a boil for the last half-hour, which is in part equal to steaming.

Red pieces and yarns may be dyed by the process just given for red grounds; or, prepare in neutral red oil, in the proportion of 150 grms. per litre of water for pieces and 15 kilos. for 100 kilos. of yarns. For pieces, pad with an ordinary machine with rollers covered with calico. Dry the pieces in the drum, and the yarn in the stove. Steam three-quarters of an hour at 1½ atmosphere. Mordant in pyrolignite of alumina at 10° B., and wash thoroughly. Dye for an hour at 70° and half an hour longer at the same heat, using for 100 kilos. of cloth or yarn 20 kilos. alizarin at 10 per cent, 10 kilos acetate of lime at 18° B., and 5 kilos. sulpholeic acid. Steam for an hour. Soap for a longer or shorter time, with or without the addition of soda crystals. There may be added to the aluminous mordant a little salt of tin to raise the tone. Lastly, aluminate of soda may be used as a mordant in place of red liquor or sulphate of alumina.

Certain firms employ a so-called continuous process. The pieces are passed into a cistern 6 metres long and fitted with rollers. This dye-bath contains from 3 to 5 grms. of alizarin per litre of water and is heated to 98°. The pieces take 5 minutes to traverse this cistern and, owing to the high temperature and the concentration of the dye liquor, they come out perfectly dyed. Two pieces may even be passed through at once, one above the other. As the dye-bath becomes exhausted, it must be recruited

from time to time with fresh quantities of alizarin. The great advantage of this method is that it economises not merely time but colouring matter.

The quantity of acetate of lime to be employed in dyeing varies with the composition of the mordant and with that of the water. Schlumberger has shown that Turkey-red contains 4 molecules of alumina to 3 of lime. Rosenstiehl has shown that alumina mordants are properly saturated if two equivalents of lime are used for each equivalent of alizarin, if the dyeing is done without oil. These figures require to be modified when the oil is put into the dye-beck, as it precipitates the lime. Acetate of lime at 15° B., obtained by saturating acetic acid with chalk and adding a slight excess of acetic acid, contains about ¼ mol. acetate of lime.—*Bulletin de la Société Chimique de Paris.*

ON M. C. FAURE'S SECONDARY BATTERY.

The researches of M. Gaston Planté on the polarisation of voltameters led to his invention of the secondary cell, composed of two strips of lead immersed in acidulated water. These cells accumulate and, so to speak, store up the electricity passed into them from some outside generator. When the two electrodes are connected with any source of electricity the surfaces of the two strips of lead undergo certain modifications. Thus, the positive pole retains oxygen and becomes covered with a thin coating of peroxide of lead, while the negative pole becomes reduced to a clean metallic state.

Now, if the secondary cell is separated from the primary one, we have a veritable voltaic battery, for the symmetry of the poles is upset, and one is ready to give up oxygen and the other eager to receive it. When the poles are connected, an intense electric current is obtained, but it is of short duration. Such a cell, having half a square metre of surface, can store up enough electricity to keep a platinum wire 1 millim. in diameter and 8 centims. long, red-hot for ten minutes. M. Planté has succeeded in increasing the duration of the current by alternately charging and discharging the cell, so as alternately to form layers of reduced metal and peroxide of lead on the surface of the strip. It was seen that this cell would afford an excellent means for the conveyance of electricity from place to place, the great drawback, however, being that the storing capacity was not sufficient as compared with the weight and size of the cell. This difficulty has now been overcome by M. Faure: the cell as he has improved it is made in the following manner:—

The two strips of lead are separately covered with minium or some other insoluble oxide of lead, then covered with an envelope of felt, firmly attached by rivets of lead. These two electrodes are then placed near each other in water acidulated with sulphuric acid, as in the Planté cell. The cell is then attached to a battery so as to allow a current of electricity to pass through it, and the minium is thereby reduced to metallic spongy lead on the negative pole, and oxidised to peroxide of lead on the positive pole; when the cell is discharged the reduced lead becomes oxidised, and the peroxide of lead is reduced until the cell becomes inert.

The improvement consists, as will be seen, in substituting for strips of lead masses of spongy lead; for, in the Planté cell, the action is restricted to the surface, while in Faure's modification the action is almost unlimited. A battery composed of Faure's cells, and weighing 150 lbs., is capable of storing up a quantity of electricity equivalent to one horse-power during one hour, and calculations based on facts in thermal chemistry show that this weight could be greatly decreased. A battery of 24 cells, each weighing 14 lbs., will keep a strip of platinum §ths of an inch wide, 1-32nd of an inch thick, and 9 ft. 10 ins. long, red-hot for a long time.

The loss resulting from the charging and discharging of this battery is not great: for example, if a certain quantity of energy is expended in charging the cells, 80 per cent of that energy can be reproduced by the electricity resulting from the discharge of the cells; moreover, the battery can be carried from one place to another without injury. A battery was lately charged in Paris, then taken to Brussels, where it was used the next day without recharging. The cost is also said to be very low. A quantity of electricity equal to one-horse power during an hour can be produced, stored, and delivered at any distance within 3 miles of the works for 1½d. Therefore these batteries may become useful in producing the electric light in private houses. A 1250 horse-power engine, working dynamo-machines giving a continuous current, will in one hour produce 1000 horse-power of effective electricity, that is to say 80 per cent of the initial force. The cost of the machines, establishment, and construction will not be more than £40,000, and the quantity of coal burnt will be 2 lbs. per hour per effective horse-power, which will cost (say) ½d. The apparatus necessary to store up the force of 1000 horses for twenty-four hours will cost £48,000, and will weigh 1500 tons. This price and these weights may become much less after a time. The expense for wages and repairs will be less than ½d. per hour per horse-power, which would be £24 a day, or £8800 a year; thus the total cost of one horse-power for an hour stored up at the works is ¾d. Allowing that the carriage will cost as much as the production and storing, we have what is stated above, viz., that the total cost within 3 miles of the works is 1½d. per horse-power per hour. This quantity of electricity will produce a light, according to the amount of division, equivalent to from 5 to 30 gas burners, which is much cheaper than gas.

CHLORO-BROMIDE OF LEAD.

By MALVERN W. ILES.

In the treatment of the Leadville carbonate ores by the blast-furnace, the writer has noticed a number of very curious and interesting compounds. The facilities here offered for an extended observation are unusually good, inasmuch as the Grant Smelting Co. works have a capacity for treating no less than 150 to 200 tons of ore per day, and an opportunity is offered for collecting furnace products from seven different furnaces.

A compound having the formula Pb(BrCl) has recently been discovered, occurring as a furnace product, in small (2¼ inch) circular openings, in the cast-iron supporting plate 11¼ inches above the water-jacket. The iron ring rests upon four cast-iron columns, and supports the sheet-iron fire-brick lined structure above. This ring-plate is perforated by holes, which serves to prevent a total rupture of the plate by the expansion caused by the internal heat.

The courses of fire-brick at the boshes close these holes from below, whilst the interior fire-brick lining covers these circular openings, thus forming a small condensation chamber in which the chloro-bromide of lead was found.

As neither Dana nor Naumann makes mention of this compound, and we have been unable to find any description given in any work at our disposal, we feel justified in stating such physical and chemical observations as we have noticed in our investigation.

In order to see whether this compound was contaminated with any silver salt, it was assayed, 1-10th assay ton yielding by cupellation only a most minute trace. Hence it is to be concluded that this was simply an accidental occurrence of a small amount of ore, or a trace of a volatile silver salt.

We have recently noticed that the white fumes that condense upon the surrounding cool objects in the vicinity of the slag tap-hole yield 3¼ ounces of silver per ton; hence it is not improbable that there is some volatile compound of silver not clearly identified, and which slightly mingles with the chloro-bromide of lead.

Properties.

The furnace crystals occurred in several forms, as, for example, in pure white, delicate, dendritic plates, not unlike crystals of lead chloride; in long acicular needles, in semi-fused distorted needles having a slightly yellowish tint, and also in entirely fused warty masses.

It dissolves in warm water, forming a milky white turbidity, which readily clears up on the addition of a few drops of nitric acid. The aqueous solution deposits plate-like crystals, and from the moderately dilute solution, by slow crystallisations, one may obtain doubly terminated acicular needles, considerably thickened in the central portion.

It sublimes on charcoal, giving a white coating. In a closed tube it melts readily to a bright red colour; upon cooling it lightens up, changing from a lemon-yellow to a pure white. On increasing the heat it sublimes in heavy oily drops. Density 5·741.

This product is found to be very stable, and is decomposed by boiling concentrated sulphuric acid, only by repeated applications, and the complete transformation into a sulphate is difficult.

Analyses.

Chlorine + Bromine.

			Per cent (Br+Cl).
0·559 grm. salt gave	0·573 grm.	(AgBr+AgCl)	=35·714
1·251 ,, ,,	1·2825 ,,	,,	35·718
1·251 ,, ,,	1·277 ,,	,,	35·566
Average of three determinations.. ..			35·666

Lead.

0·559 grm. salt gave	0·513 grm.	$PbSO_4$	=62·695 p. ct. Pb.
1·086 ,, ,,	0·996 ,,	,,	62·717 ,, ,,
1·251 ,, ,,	1·167 ,,	,,	63·729 ,, ,,

The first and second determinations were made upon the furnace product, while the substance used for the last determination was the result of purification by crystallisation from an aqueous solution.

Bromine.

1 grm. fused (AgCl+AgBr) gave a loss on passing dry pure chlorine gas over the salt, in a bulb tube, of 0·141 grm. = 0·595055 grm. AgBr = 25·321 per cent Br.

The formula Pb(BrCl) requires Pb = 64·186 per cent and (Br+Cl) = 35·814 per cent. We may state our results as follows:—

Found.		Calculated.	
Pb	63·729 per cent.	Pb	64·186 per cent.
Br	25·321 ,,	Br	
Cl	10·345 ,,	Cl	35·814 ,,
	99·395		100·00

The mixed silver salt was readily prepared by making an aqueous solution (aided by a few drops of nitric acid), and adding silver nitrate; after purification, by washing with hot water, the salt was dried and analysed. 0·570 grm. (AgCl+AgBr) was mixed with pure granulated lead and cupelled in the assay muffle, of course after scorification, and the usual precautions taken for rich chloride ores. The weight of the silver button was 0·36345 grm., which corresponds to 63·763 per cent silver; theoretical percentage for formula = 65·158 per cent.

A chloro-bromide of silver, or embolite, has been described and analysed by Prof. Th. Richter,* which closely corresponds to the above compound, termed *megabromite* by Breithaupt.

Prof. Richter's analyses gave Ag = 64·19 per cent, Br = 26·49 per cent, Cl = 9·32 per cent. The ratio of the bromine to the chlorine 1 : 0·8, whilst we found in the compound under consideration a ratio of 1 : 0·92.

* Berg- und hüttenmännische Zeitung, 18, 449.

Inasmuch as the furnaces from which the chloro-bromide of lead was collected had been in blast for some time, it is reasonable to conclude that the chloro-bromide of silver existing in these ores has the same general composition as shown in the above haloid silver salt. While we do not deny the probability that the chloro-bromide of lead may have existed in the ores as such, yet it can readily be seen how a decomposition may have taken place in such a manner as to produce this lead salt, since it is a well-known fact that heated metallic lead will decompose all known salts of silver. In conclusion we may state that samples of this compound have been forwarded to Profs. Richter, Dana, Remsen, Chandler, and others.—*American Chemical Journal.*

Chemical Laboratory, Grant Smelting Co.,
Leadville, Colorado.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 5, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—G. H. Bostock, W. Bedford, J. M. Collett, A. E. Davies, J. E. Doyle, C. W. Marsh, A. Philip.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators (Dr. Hugo Müller and Prof. McLeod) to be duly elected Fellows of the Society:—A. J. Anderson, F. J. O. Farroll, T. R. Ord, G. E. Robinson, A. J. Shilton, W. R. Smith, F. P. Venable, G. H. With.

The following papers were read:—

"*On the Action of Humic Acid on Atmospheric Nitrogen*," by E. W. Prevost. The author has repeated the three following experiments of E. Simon (*Land. Vers. Stats.*, xviii.):—(1) Humic acid and water were sealed up in a tube containing nitrogen; (2) nitrogen was passed for twelve hours through a Liebig's potash bulb containing water and humic acid; (3) humic acid and water were placed in an ordinary flask, whose mouth was closed by a caoutchouc stopper. In all these experiments Simon states that perceptible quantities of ammonia were formed. The author was unable to confirm this statement: in only one case was any formation of ammonia observed. In this experiment 3 grms. of humic acid were hermetically sealed in a glass tube with 20 c.c. of water and 76·6 c.c. of air, and exposed to the light for eighteen months; at the end of that time the water contained ammonia equal to 0·19 c.c. of nitrogen. The author used two samples of humic acid, one purchased from Hopkin and Williams, the other prepared by himself from peat: the humic acid was not soluble in water.

Dr. Gilbert said that he was disposed to agree with the conclusions of Dr. Prevost that there was at present no proof of absorption of nitrogen from the air by ordinary soils. With cereal crops 20 lbs. of nitrogen could be taken out of a soil per acre, and then a distinct decrease in the nitrogen in the soil could be noticed by analysis; but in the case of the Leguminosæ the case was not so clear. For instance, 200 lbs. of nitrogen could be removed per acre with a clover crop, and yet not only was there no decrease in the nitrogen in the soil, but in the surface soil an increase could be proved, after the removal of the crop. Where this increase came from has not been satisfactorily settled. One theory was that it came from the nitrogen in the air; another, that the wide-spreading clover roots abstracted the nitrogen from a considerable depth of soil, and from the falling leaves, &c., the nitrogen in the surface soil increased. It must also be considered that there was some difficulty in getting a fair sample of the soil, and

that the quantity of combined nitrogen in an acre of ordinary soil 4 ft. 6 ins. deep was enormous (about 10,000 lbs.) as compared to the above quantities. Again, although clover crops are to a certain extent indifferent to nitrogen, they do not get on in a soil where there is no nitrogen.

"*On the Active and Inactive Amylamines, corresponding to the Active and Inactive Alcohols of Fermentation*," by R. T. PLIMPTON. The author has studied these bodies in order to see whether any differences similar to those which distinguish active from inactive amyl alcohol can be detected in their corresponding derivatives. The inactive amylamines were obtained by heating the mixed alcohols with gaseous hydrochloric acid (*Comptes Rendus*, lxxvii., 1021), which first attacks the inactive alcohol: a quantity of inactive amyl chloride was thus procured. The chloride was heated with its own volume of saturated alcoholic solution of ammonia, and the resulting hydrochlorides distilled with potash. The amylamines so obtained were separated by fractionation, &c. Monamylamine (boiling-point, 96° to 97°) had no action on polarised light. Diamylamine (boiling-point 185° to 186°); the hydrochloride is insoluble in ether. Triamylamine (boiling-point 237°); the hydrochloride is soluble in ether. In each case the platinochloride, aurochloride, and the hydrochloride were prepared and examined. Active amylamines:—About 3 litres of the mixed alcohols were distilled in a current of hydrochloric acid for five weeks, until the quantity was reduced to 760° grms. in a 10 c.m. tube; rotation = 4°. The monamylamine was obtained partly by converting the alcohol into cyanate and cyanurate of amyl and boiling with potash, and partly by heating the bromide to 100° with alcoholic ammonia. A length of 10 c.m. rotated 3° 5′ to 3° 30′ to the left; boiling-point 96° to 97°; its hydrochloride is deliquescent, and its solution rotates feebly to the right. The diamylamine was obtained by heating the active amyl bromide to 130° with its own weight of alcoholic ammonia (boiling-point 182° to 184°); 10 c.m. rotated 5° 15′ to the right; the hydrochloride is easily soluble in water, alcohol, and ether; it is optically more active than the free amine. The triamylamine was obtained by heating the active diamylamine with amyl bromide (boiling-point 230° to 237°; 10 c.m. rotated 44° 15′ to the right. The auro and platino-chlorides were prepared. The salts of the active amylamines differ from their inactive isomers in being deliquescent and difficult to crystallise; they are also more soluble. The inactive salts, on the other hand, crystallise well; the boiling-points and specific gravities also differ slightly. A Cornu polariscope was used, and the rotation is given for the yellow ray.

"*On the Action of Sodium Alcoholates on Fumaric Ethers*," by T. PURDIE. Wislicenus long since investigated the action of the alkali metals on ethyl fumarate: sodium had no action at ordinary temperatures, but potassium acted vigorously, producing, however, such a complicated reaction as to offer but little prospect of elucidation. More recently, by the action of sodium ethylate in alcoholic solution, and subsequent addition of methyl iodide, a dibasic acid was obtained, which had the formula $C_6H_{10}O_5$. The author has undertaken this research to determine the constitution and mode of formation of this acid. The fumaric acid was prepared in the usual manner from malic acid. The ethylic ether was prepared in three different ways:—By leading hydrochloric acid gas into a mixture of alcohol and acid: by heating the acid with sulphuric acid and alcohol; by the action of silver fumarate on ethyl-iodide. The first method is attended with certain disadvantages. The action of sodium ethylate and methyl iodide on ethyl fumarate was conducted according to the well-known method used at Würzburg in the preparation of the organic disubstituted aceto-acetic ethers. At first two molecules of methyl iodide were used to two atoms of sodium and one molecule of ethyl-fumarate; finally half the quantity of sodium and methyl iodide was used in order to secure a better yield. The mixture was heated for twenty minutes, when it had a neutral reaction. On the addition of water an oil separated, boiling at 225°; it proved to be the acid $C_6H_{10}O_5$; it was converted into a lead salt, which was decomposed by sulphuretted hydrogen. The pure acid crystallised *in vacuo*, melted at 86°. When ethyl iodide was substituted for methyl iodide in the above reaction the same acid was obtained. Finally, the action of sodium ethylate alone on ethyl-fumarate was studied; the same acid was produced. Subsequent investigation confirmed the view that it was an ethyl-ether malic acid,—

$$\begin{cases} CH(OC_2H_5)COOH \\ CH_2COOH \end{cases},$$

isomeric with Desmondesir's monethyl malate. The author has studied its properties, and formed its calcium, barium, and silver salts. The action of sodium isobutylate on isobutyl-fumarate was investigated in a similar way; isobutyl malic acid,—

$$\begin{cases} CH(OC_4H_9)COOH \\ CH_2COOH \end{cases},$$

was obtained, and its salts studied. When sodium ethylate free from alcohol is added to ethyl-fumarate an addition-product is apparently formed, from which, possibly, by the addition of alcohol iodide, the synthesis of homologous acids might be effected. The author promises further research on this subject.

"*On the Products of the Action of Alkalies on Ethylic β-ethyl-aceto-succinate*," by L. T. THORNE. By the action of strong potash, an ethyl-succinic acid was obtained identical with that prepared from α-ethyl-aceto-succinic ether. When, however, weak (5 per cent) potash solution was used α-ethyl-β-aceto-propionic acid was formed, which on attempted distillation gave off water, a new substance, $C_7H_{10}O_2$, being at the same time formed. This substance is a colourless oily liquid, with neutral reaction and pleasant smell, boiling at 219°, vapour-density 5·014. The author hopes to be able to resume the investigation and settle the constitution of this substance, which he therefore leaves unnamed.

"*On some Carbazol Compounds*," by E. H. RENNIE and W. R. HODGKINSON. The authors have studied the action of potassium carbazol (obtained by dropping potassium into melted carbazol) on ethyl-chloro-carbonate; white crystals were obtained having the formula,—

$$(C_6H_4)_2NCOOC_2H_5.$$

The substance may be looked upon as a new urethane.

The Society then adjourned to May 19, when the following papers will be read:—"On the Reaction between Hydrogen and Nitric Oxide in the Presence of Spongy Platinum," by Lewis T. Wright; "A Method for the ready Estimation of a Soluble Sulphide and Free Sulphurous or Free Sulphuric Acid, even in the Presence of Sulphates," by O. V. Pisani.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Monday, May 2, 1881.

WILLIAM BOWMAN, LL.D., F.R.S., in the Chair.

THE Annual Report of the Committee of Visitors for the year 1880, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The Real and Funded Property now amounts to above £85,400, entirely derived from the Contributions and Donations of the Members.

Forty-nine new Members paid their admission fees in 1879.

Sixty-two Lectures and Nineteen Friday Evening Discourses were delivered in 1880.

The books and pamphlets presented in 1879 amounted to about 166 volumes, making with 555 volumes (including periodicals bound) purchased by the Managers, a total of 721 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year.

President—The Duke of Northumberland, D.C.L., LL.D.

Treasurer—George Busk, Esq., F.R.C.S., F.R.S.

Secretary—Warren De La Rue, Esq., M.A., D.C.L., F.R.S., Cor. Mem. Inst. France, &c.

General Monthly Meeting, Monday, May 9, 1881.

George Busk, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

The following Vice-Presidents for the ensuing year were announced :—William Bowman, F.R.S.; Frederick Joseph Bramwell, F.R.S. ; Sir W. Frederick Pollock, Bart., M.A. ; William Spottiswoode, D.C.L., F.R.S., Pres. R.S. ; George Busk, F.R.S., Treasurer ; Warren De La Rue, M.A., D.C.L., F.R.S., Secretary. Frederick Arthur Crisp, Ernest Gye, and Samuel Armstrong Lane, F.R.C.S., were elected Members.

John Tyndall, D.C.L., LL.D., F.R.S., was re-elected Professor of Natural Philosophy.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

Monday, April 4, 1881.

Mr. R. R. Tatlock, F.I.C., F.R.S.E., in the Chair.

Mr. C. Hope, of St. Rollox Chemical Works, read a paper on "*Analysis of Soaps.*" He said :—

In this paper to the Section I intend giving, for the full analysis of soda soaps, a method which I have used for some considerable time, and which I find to be useful in giving information as to how the soap has been made, and also as giving an exact analysis of it, which is much desired by some consumers, and not usually done by analysts. In some cases a much shorter analysis will suffice, but in a soap works laboratory the full one will be very often wanted. Before weighing off portions of the soaps I think it is absolutely necessary to cut off the outer skin and take the inside, otherwise discrepancies will result not otherwise to be accounted for. The skin is a very small portion, usually of the bar or cake, and it would be a difficult operation to get the proper amount of skin in the different portions weighed.

Water.—The first thing to be done is to cut some thin shavings of the sample, weighing about 5 grms., and place them in a small, tared, flat porcelain basin, and the exact weight noted. It is then put in the water-bath, and heated until it ceases to lose weight; a night generally suffices for this purpose. When that is done it is weighed in the morning, and a number of small holes made with a pin in the dried slices, and put in the bath again for a few hours and re-weighed. If there is no further loss, as is generally the case, it is certain the soap is thoroughly dry. Some chemists have condemned this method of estimating the water, because they say it fails to give off the last 1 or 2 per cent ; but I find that such is not the case, because when a soap is dried as I have described, it will give no further loss even if heated to its decomposing point.

Fatty Acids.—A portion of the soap, weighing about 5 grms. in the form of miniature bars, is introduced into a separating funnel of about 120 c.c. capacity, and about 50 c.c. of water at, say, 100° F. poured in, then enough acetic acid to decompose the soap and leave a small excess, and finally about 50 c.c. of ordinary ether. The stopper is then put in the funnel, and the whole shaken until the soap is all dissolved. It is then allowed to settle for a few minutes, when the fatty acids will be found to have dissolved in the ether, and floating on the watery solution which contains the soda salts, &c. The bottom stopper is then opened slightly, and the watery solution of the salts allowed to *drop* slowly out until it stops, then the top stopper is taken out, and the remainder of the water allowed to drop slowly out until only a few drops remain, at which time the stopper is shut. The funnel is then filled up with water about 90° or 100° F., the stopper replaced and shaken for a minute or so, allowed to settle, and the same operation as before repeated. The washing is continued until the washings are neutral, at which point the last few drops are allowed to go out, taking care not to allow any of the etherial solution to follow it. It is always necessary to open the bottom stopper first, as there is enough ether vapour in the funnel to cause an outward pressure, which on opening the top stopper first causes a few small drops of the ether solution to splutter out, a proceeding not to be desired, and which is effectually prevented by operating as described. The dropping of the washings is to be carefully done, otherwise the washings will be found to have a skin of fatty acids floating on the surface, which of course would cause a low result, and therefore must be carefully guarded against. The etherial solution of the fatty acids is then poured out by the top of the funnel into a previously-tared beaker of about 150 c.c. capacity, and the funnel rinsed out with fresh ether. The beaker is then covered with filter paper and placed on the top of the water-bath until the ether is evaporated. If the odour still remains in the beaker a few minutes inside the bath remove it completely. If the water has not been completely removed from the funnel, a few small drops of water will be seen in the fatty acids and may be removed by the addition of a few drops of absolute alcohol, and then heated inside the water-bath until its odour is gone. The beaker is now cooled and weighed, and when the tare is deducted gives the weight of fatty acids in the quantity of soap taken.

Total Alkali.—For this determination I take 31 grms. of the soap, and put it into a 500 c.c. flask, and dissolve with the aid of heat in hot water. 50 c.c. of standard sulphuric acid are then added, and the flask filled up to the mark ; 100 c.c. are filtered off, put into a beaker, and titrated with standard pure caustic soda, using litmus as an indicator. The acid used is a normal one, 1 c.c. = 0·062 grm. Na_2O, and the soda is one-tenth of that strength, 1 c.c. = 0·0062 grm. Na_2O.

Sodic Chloride.—To the above neutralised solution some solution of yellow chromate of potash is added, and then titrated with a decinormal solution of silver, 1 c.c. = 0·00585 grm. NaCl.

Free Alkali.—3·1 grms. of the sample in thin shavings are weighed off and dissolved in rectified alcohol, then filtered as rapidly as possible, and the insoluble matter washed with boiling alcohol. A few drops of alcoholic solution of phenol thalein are added to the filtrate, and then titrated with the decinormal acid. This gives the free alkali existing as hydrate, usually only a trace or none.

Soda existing as Silicate and Carbonate.—The part insoluble in alcohol is dissolved on the filter with hot water, carbonic acid passed into the filtrate to precipitate a trace of lime usually in it, then thoroughly well boiled, and filtered. The filtrate is then titrated with the decinormal acid, using litmus as indicator.

Soda existing as Carbonate.—5 grms. of the soap are dissolved in rectified alcohol, washed as before, and the insoluble dissolved in water. The solution containing the carbonate and silicate is put into a flask fitted with a set of two U-tubes containing solution of baric hydrate, and decomposed with dilute acid, and the CO_2 boiled out into the U-tubes. The baric carbonate is filtered off as quickly as possible, the excess of hydrate washed from it, and the precipitate titrated with standard decinormal acid.

Sulphate of Soda.—10 grms. of the soap are dissolved in water decomposed with HCl, and the fatty acids

filtered off. The filtrate is precipitated with $BaCl_2$, and finished in the usual manner.

Silica.—25 or 50 grms. are ignited in a platinum basin, and the residue treated with HCl, evaporated to dryness, retreated with HCl, and the insoluble silica filtered off, ignited, and weighed.

Lime, Iron, &c.—The filtrate from the silica is made alkaline with ammonia, some oxalate of ammonia added, the precipitate collected, ignited, and weighed.

Calculation and Statement of Results.—The water, silica, lime, &c., and sodic chloride are simply calculated to per cent. The barium sulphate is calculated to per cent of sodic sulphate. The alkali soluble in alcohol is calculated to NaHO, and the acid used for titrating the baric carbonate to sodic carbonate. The "soda existing as carbonate" is deducted from the "soda existing as silicate and carbonate," and the difference stated as "soda existing as silicate." The silica cannot be stated as silicate of soda because the "silicate" as used and as it exists in the soaps is not a normal one. It has an approximate composition of Na_2O2SiO_2, but it is evidently not a definite compound, so that under those circumstances it is necessary to state the silica as such, and give the soda existing with it. It was pointed out by a writer in the Chemical News some years ago, and seems to be still ignored, that although in the process of analysis the fat is separated and weighed as fatty acid, it exists in the soap as fatty anhydride, as the following reaction representing the decomposition of sodic oleate by an acid shows:—

$$2\left\{\begin{matrix}C_{18}H_{33}O\\Na\end{matrix}\right\}O+2HCl=2NaCl+2\left\{\begin{matrix}C_{18}H_{33}O\\H\end{matrix}\right\}O,$$

and that by multiplying the fatty acids by the factor 97, the true weight of fatty matter existing in the soap was found. If the fatty acids are stated in the analysis it will be found that the analysis will total to nearly 102; therefore, because the per cent of fatty acids are usually wanted, I generally report the analysis in the following manner:—

	Per cent.
* Fatty anhydride	
Soda existing as soap	
Water	
Sodic carbonate	
,, hydrate	
,, chloride	
,, sulphate	
Silica	
Soda existing as silicate	
Lime, &c.	———

* = Per cent fatty acids
Per cent total soda.

There are two other important points in connection with soap analysis, viz., the determination of the resin, and the melting-point of the fatty acids, that I intended to speak of in this paper, but I have not been able to get the experiments finished, so that I must leave them for a future communication to the Section. A method for the accurate determination of resin in soap, whether easy of execution or otherwise, is a thing still wanted. I have been working lately at a method which, although not a quick one, promised well for accuracy, and which I now find to give results short of the truth, because of the different resinic acids in rosin having different solubilities in certain reagents.

The Secretary, Dr. Dobbie, read a paper by Mr. R. Thomson, Mr. E. B. Clark, and himself "*On the Occurrence and Composition of Eugenite and other Rare Minerals.*" In this paper the authors described the conditions under which the minerals were found, and gave a short account of the methods employed by them in separating the rare elements contained in the minerals from one another.

Dr. Dobbie read a short paper "*On the Conversion of Dolomitic Limestone into Serpentine.*"

The Chairman intimated that this meeting was the last for the present session, and congratulated the Section on the success which had attended their meetings throughout the past winter.

CORRESPONDENCE.

THE SO-CALLED "BUNSEN PUMP."

To the Editor of the Chemical News.

Sir,—Prof. Roscoe, President of the Chemical Society of London, in enumerating the works of his friend Prof. Bunsen, says, in *Nature* of the 28th ult. ("Scientific Worthies," p. 600):—"To him we are also indebted for the apparatus for accelerating filtration, the "Bunsen pump," together with all its appliances, now employed in every laboratory."

This assertion requires correction. The pump used by Prof. Bunsen for accelerating filtration was invented by me, and not by Prof. Bunsen, as would appear from the use of his name in connection with it. I described the construction of the *water* air-pump distinctly and plainly in the *Journal of the Chemical Society of London* for January, 1865, under the title "Researches on the Vacuum: I. The Instruments" (not the instrument, as some will read) and I sent a copy of this paper to Prof. Bunsen, inscribed with a suitable allusion to our former relationship as pupil and teacher, during the spring of 1865. Three years later Prof. Bunsen published his paper "On the Washing of Precipitates," in which he describes again my pump, *but unfortunately omitted to quote my paper of* 1865.

The following is a translation of Prof. Bunsen's own words:—

"To create the difference of pressure for filtration, one cannot employ any of the air-pumps commonly used, especially not the mercury air-pump, as the liquids to be filtered contain not unfrequently chlorine, sulphurous acid, sulphuretted hydrogen, and other substances, which would destroy the metallic portions of the apparatus. I therefore employ a water air-pump constructed of glass on the principle of Sprengel's mercury air-pump, which for all chemical purposes is, as I believe, preferable to every other apparatus for air-rarefaction, where it suffices to push the rarefaction no further than to a pressure of mercury from 6 to 12 millimetres."—(*Ann. Chem. Pharm.*, 1868, vol. 148, p. 277.)

The peculiar stress laid here on the uselessness of mercury air-pumps, and on the fact that chlorine attacks mercury, combined with the omission of all reference to my paper, where both *water and glass* are mentioned, gave to Prof. Bunsen's description of the instrument a colour of originality, which Prof. Roscoe (and with him many others) think right to support and to perpetuate by calling it the "Bunsen pump."

As this misnomer has been already the subject of a disclaimer from Prof. Bunsen (Chemical News, vol. xxvii., p. 49, 1873) of remonstrances both from myself (*Ibid.*), from Prof. Frankland (*Nature*, 1876, vol. 14, p. 74), and from others, I am sorry to see that Prof. Roscoe should continue to use this designation, which is intended to honour an "*employer*" of the instrument, which hurts the feelings of its inventor and deprives him of his only reward—the satisfaction of being credited with having placed a useful servant at the disposal of Science and Industry.

If any other inventor less eminent than Prof. Bunsen had made the omission, which I have pointed out with much reluctance, no one would persist in giving his name to my child; nor (reversing the case) would anybody speak of a pump as "Sprengel's pump," if I had received from Prof. Bunsen the paper of 1865, and said in 1868, "I therefore employ a water air-pump constructed of glass on the principle of Bunsen's mercury air-pump." This misnomer is the result of a reprehensible hero-worship. Hero-worship is all very well, and quite harmless, pro-

vided it is cultivated with a due regard to other people's property—otherwise it ceases to be so. For this reason I think it a duty to myself, as well as to other inventors, that I should record on this occasion my courteous protest against this unwarranted disposal of my property by the President of the Chemical Society of London.—I am, &c.,

H. Sprengel.

London, Savile Club, May 7, 1881.

THE SOCIETY OF CHEMICAL INDUSTRY.

To the Editor of the Chemical News.

Sir,—"Caustic Alkali" (Chemical News, vol. xliii., p. 194) is too flattering. I do not suppose that my views would have greatly influenced his committee, even if made known earlier, and still less that they can damp the prospects of the Society now that it is fairly launched. I may say, however, that I did not gather from what went before the last meeting, at which I was unfortunately unable to be present, that the Society was so ripe for constitution. My remarks are rather to be taken as a heavy groan, whereby I relieved my own mind. I am, however, gratified to find that "Caustic Alkali" endorses my view that the new Society might have been affiliated to the Chemical Society. I should be glad to know why such a proposal was not made at a general meeting of the Fellows of the Chemical Society.

Something of the divided feeling which I deplore to see between chemists, is to be observed in "Caustic Alkali's" reference to the Institute. I think our profession is altogether too young to bear the strain of much division. It seems to me, also, that, instead of quietly waiting until, by the "long result of time," we slowly *grow* into importance, there is too much tendency to be constantly posing before the public as being already a very important body. It is a part of the unhealthy haste of the present day.

As a technical chemist, connected for nearly twelve years with a very large concern, in connection with which I have succeeded in establishing important improvements, I shall be only too glad if the new Society can break down some of the barriers to the advancement of technical chemistry. But I must still regret that in doing so, it should be thought necessary to further tax our profession in time and money, when, by slightly extending existing organisations, the same end might have been reached at less expense, and unity among chemists promoted at the same time.—I am, &c.,

F.I.C., F.C.S.

THE ALLEGED IDENTITY OF THE RED COLOURING-MATTER OF WINES AND OF THE BILBERRY.

To the Editor of the Chemical News.

Sir,—It has lately been stated repeatedly that the red colouring matters of wine and of the bilberry are identical. These statements are, however, it seems to me, based on insufficient grounds; for, however closely these colouring-matters may resemble each other, the red colouring-matter found in genuine red wines is certainly not *identical* with the red colouring-matter of the bilberry.

To show this it is only necessary to make use of the simple test described by the writer in 1876 (*Analyst*, Nos. 2 and 11), namely, submitting the colouring-matter to dialysis. In a paper published in the *Journ. Chem. Soc.*, August, 1880, the statement will be found that the colouring-matter of bilberries *dialyses*, whereas it had previously been shown the red colouring-matter of pure wines *does not dialyse*.

The spectroscope is undoubtedly, in practised hands, an admirable means for the detection of certain colouring-matters which may have been added to a wine. For the discovery, however, of the broad fact, whether or no a foreign colouring-matter has been added to a wine, the spectroscope is nothing like so certain in its application as the gelatine cube, and even for the detection of the special colouring-matter employed it is in but few cases of greater use.—I am, &c.,

A. Dupré.

Laboratory, Westminster Hospital, London, S.W., May 7, 1881.

PITCH-HOUSE EXPLOSIONS IN TAR DISTILLERIES.

To the Editor of the Chemical News.

Sir,—With regard to the letter of your correspondent "Hydrocarbon," I may just say that when connected with the tar distilling industry, two cases of explosion of the kind mentioned by your correspondent came under my direct notice. The theory of spontaneous ignition I cannot, however, see my way to accept, and the temperature of the melted pitch, though high, is not high enough to fire a mixture of air and such hydrocarbon vapours. There is one prolific source of danger of explosion, however, in cases of this kind, which I will mention, and I believe it to be the almost invariable cause. This is the presence of fire, red-hot embers, red-hot iron, or other surfaces, &c., in the immediate neighbourhood of the tar still-tap, or of the inlet by which the highly heated and molten pitch runs to the covered gutter or main leading it to the pitch house. The presence of fire or red-hot substances in such a place is easily explained. When a tar still is to be run off, and this is generally late at night or very early in the morning to avoid nuisance, the large tap is often found to be blocked up and immovable with pitch of a former running off. The still man therefore usually takes a shovelful of fire from a still furnace and applies this to the tap in order to melt the adherent pitch, and, seeing this accomplished, the man *sometimes* at once lays down the shovel *with the embers still upon it*, and applies the tap-key, turns the tap, and, forgetting his shovel, turns away to avoid the smoke of the pitch. If the shovel be pretty near this inlet, and the wind in its direction (and there will certainly be a slight draught or current down the covered gutter or main caused by the motion of the swiftly flowing pitch), a flame may pass down the gutter under given conditions of admixture with air, and fire the contents of the pitch house, causing an explosion. The danger mentioned is still greater when, as in some large works, two stills are run off soon after one another, and firing the tap has to be resorted to in the case of the second still. Here the pitch house is thoroughly charged with inflammable vapours from the pitch of the still first run in, so that on firing the tap of the second still, even the approximation of the fire (and some embers might easily be dropped), may be sufficient to fire the gaseous mixture in the still-smoking main. Sometimes this running-off process has to be performed in the dark, and a *lantern* is used, and perhaps carelessly. Or, again, the hour for this process being as mentioned either a late or very early one, the man, though knowing the practice to be a prohibited one, taking advantage of the foreman's absence, may be going to work with a lighted pipe in his mouth. Davy lamps it is true are used in some distilleries, but the men, like the colliers, often strive to evade the use of them, because of the feeble light afforded. If the distillation had been carried very far, the pitch being in part almost coked, its temperature on running off must be very high, in order to remain fluid; in fact, fresh from the still tap any organic matter, such, for example, as a piece of paper, would be charred on coming in contact with it, and I could even imagine the possibility of its smouldering or even taking fire under certain exceptionally favourable conditions. Of course, also, in the case of a still under such circumstances, the danger of firing the tap incautiously will have reached a maximum.—I am, &c.,

Watson Smith, F.C.S., F.I.C.

The Owens College, Manchester.

METHOD OF TESTING THE VALUE OF INSOLUBLE PHOSPHATES.

To the Editor of the Chemical News.

Sir,—Prof. Robert Galloway in his letter to the Chemical News, vol. xliii., p. 209, condemns the citrate of ammonia process for estimating retrograde phosphates, because there is no citric acid present in the soil to carry out the process of dissolving on a large scale. I fail to see the relevancy of his proposition. Agricultural chemists agree pretty well that even phosphates soluble in water retrograde in the soil when coming into contact with lime, oxide of iron and alumina, and that plants assimilate the phosphates to a very large extent in this retrograde state, probably with the assistance of a series of organic acids in the soil. Of course, in artificial manures, soluble phosphates are to the farmer far more valuable than insoluble or even retrograde phosphates. The former being for a certain time kept in solution, distribute through soil or sub-soil to far greater an extent than could possibly be accomplished by any other means of mechanical subdivision. The analytical chemist is thus entitled to base his method of estimation upon the action of a chemical reagent, such as citrate of ammonia, on the retrograde phosphates, without distinction whether the latter has been formed in the factory, the store house, or in the soil, as long as he places phosphates soluble in water upon a higher commercial standard.—I am, &c.,

Julius Ostersetzer.

Dublin, May 9, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 13, March 28, 1881.

Formation-Heat of Diallyl, of the Chlorated Bodies, and of Aldehyd.—MM. Berthelot and Ogier.—On comparing the formation-heats of diallyl and dipropargyl it is seen that formations effected according to like equations do not necessarily give rise to the same thermic phenomena in the series of the carbides of hydrogen any more than among elementary bodies. The substitution of chlorine for hydrogen in organic compounds gives rise to considerable thermic effects, which diminish with the number of equivalents substituted, and which vary with the series and the chemical function.

Remarkable Case of Globe-Lightning and of Diffused Lightning near the Surface of the Ground.—A. Trécul.—On August 25, 1880, the author saw in full daylight a very brilliant yellowish white body issue from a dark cloud. It had a well-defined outline and seemed to re-enter the cloud, but left behind it a small portion of its substance, which fell perpendicularly, like a heavy body, leaving behind it a luminous train, bordered with sparks, or reddish globules. During its fall it became divided, but without the production of any sound. The diffused light has been often observed during electric storms, and probably belongs to the same class as the fire of St. Elmo.

Attempt to Apply the Principle of Carnot to Electro-chemical Action.—G. Chaperon.—A mathematical paper, not suitable for abstraction.

Construction of Photophonic Selenium Receivers.—E. Mercadier.—These receivers are made by taking two slips of brass 1-10th m.m. in thickness, 0·01 m. wide, and from 1 to 5 metres in length. They are separated by two slips of parchment paper of about 0·15 m.m. in thickness. The whole is rolled up in a coil as tight as possible, and kept together by means of two pieces of wood held by two screws. The two surfaces are polished with the file. The apparatus is then heated in the sand-bath to the temperature at which selenium begins to melt. A stick of selenium is drawn along its surface, and the layer receives the characteristic slate colour indicated by Bell. These receivers are continuous and have the same properties as the ordinary discontinuous receivers, plane or cylindric.

Disturbing Causes which Affect Telephonic Transmission.—A. Gaiffe.—It is probable that the vibrations caused by the wind act upon the wire lines like shocks. The author thinks that to avoid such perturbations it will be necessary to cause the telephones to speak by means of electric action sufficiently powerful that the currents produced in the line itself may not be appreciable.

Preparation and Properties of Chromous Chloride and Sulphate.—H. Moissan.—The author has prepared chromous chloride by the action at red heat of a current of dry hydrochloric acid upon melted chromium prepared by the process of M. Deville, or by the action of ammonium hydrochlorate upon chromium sesquichloride. The sesquichloride is heated to redness in a tube of Bohemian glass, and the vapours of the hydrochlorate are passed over it.

Phospho-platinic Compounds.— E. Pomey.—The author has attempted to form $P(C_2H_4Cl)_3PtCl_2$ by the action of phosphorus perchloride upon the phospho-platinous ether of Schützenberger, but without success.

Products of the Action of Ammonium Hydrochlorate upon Glycerin.—A. Etard.—The result of the reaction is a liquid alkaloid, $C_6H_{10}N_2$, which the author names glycolin.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. Part 7, 1880.

Appreciation of Patents Granted in Germany.—VII. Class 8, Bleaching, Dyeing, Tissue-Painting, and Finishing.—Dr. H. Grothe.—The reproduction of this paper is specially interdicted, as is very frequently the case with memoirs of general interest. It may strike the reader as singular that such a subject was not entrusted to a colourist rather than to an engineer, who has naturally given his main attention to the machinery employed in the above-named arts.

Part 8, 1880.

Experiments on the Spontaneous Ignition of Coal.—H. Hædicke.—The reproduction of this memoir is formally prohibited.

Part 10, 1880.

This number contains no chemical matter.

Reimann's Färber Zeitung, No. 6, 1881.

A tolerably correct account is given of Nesbitt's patent process for preventing tampering with cheques. The writer assumes, however, that no one would use "so fugitive a colour as litmus for such a purpose," and that the paper is "probably coloured blue with ultramarine," which is a complete mistake.

M. Salzmann and F. Krüger patent a process for the preparation of red, violet, and green dyes by the action of chloropicrin upon the aromatic amines. Aniline and its homologues, in the state of free bases, or as salts, and with or without an addition of metallic chlorides, is heated for a length of time to 100° to 210°, along with chloropicrin. There are produced red dyes soluble in water, and violets soluble in alcohol, which can be converted into sulphacids.

No. 7, 1881.

According to a correspondent from Mulhouse, the new aniline oil for producing ungreenable aniline-blacks is not

very successful. Impure aniline-oils have always given a black less liable to turn green.

A process is said to have been discovered for printing alizarin steam-reds upon unoiled calico. A new steam indigo-blue and a process for fixing aniline ponceau upon cotton are spoken of, but the particulars have not transpired.

No. 8, 1881.

This number contains nothing of general interest.

MISCELLANEOUS.

Society of Arts: Cantor Lectures.—The fifth and concluding course of Cantor Lectures for the present Session, at the Society of Arts, will be by Mr. R. Brudenell Carter, on the subject of "Colour Blindness, and its Influence on Various Industries." The course consists of three lectures, the first of which will be delivered upon Monday next, the 16th inst. This lecture will deal generally with the subject. The second lecture will treat of methods of testing for colour blindness, the prevalence of the affection, mistakes of the colour blind, and methods of endeavouring to counteract the defect. The subject of the third lecture is specially the industries chiefly affected by colour blindness. In it an account will be given of recent legislation on the subject in America, and the necessity for it in this country.

MEETINGS FOR THE WEEK.

Saturday, 14th.—Physical, 3. "Electric Absorption in Crystals," Prof. H. A. Rowland and E. H. Nichols. "An Absolute Line Galvanometer," Prof. G. M. Minchin. "The Ascent of Hollow Glass Bulbs in Liquids," Dr. E. J. Mills, F.R.S.

Monday, 16th.—Society of Arts, 8. "Colour Blindness, and its Influence upon Various Industries," R. Brudenell Carter, F.R.C.S.

Tuesday, 17th.—Civil Engineers, 8.

—— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.

Wednesday, 18th.—Society of Arts, 8. "The Electrical Railway, and the Transmission of Power by Electricity," Alexander Siemens.

—— Meteorological, 7.

—— Pharmaceutical (Anniversary), 11.

Thursday, 19th.—Royal Institution, 3. "Magnetism," Professor Tyndall.

—— Royal, 4.30.

—— Philosophical Club, 6.30.

—— Chemical, 8. "On the Reaction between Hydrogen and Nitric Oxide in the Presence of Spongy Platinum," Lewis T. Wright. "A Method for the Ready Estimation of a Soluble Sulphide and Free Sulphurous or Free Sulphuric Acid, Even in the Presence of Sulphates," O. V. Pisani.

Friday, 20th.—Royal Institution, 8. "Shakespeare Criticism," Mr. W. H. Pollock, 9.

Saturday, 21st.—Royal Institution, 3. "Russian Literature: Pouschkin," Prof. C. E. Turner.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1121.

NOTES ON THE OXIDES OF MANGANESE.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon, F.C.S., Assistant Master at Highgate School.

(Concluded from p. 214.)

§ VIII. *Molecular Alteration gradually taking place in these Oxides.*

The curious facts to be described in this paragraph throw new and great difficulties in the way of any investigation on the oxides of manganese and at the same time detract considerably from the value of the above results.

Some time after the experiments on the oxide No. 4, Table IV., were made, I found occasion to repeat some of these experiments, and was considerably surprised on observing that, instead of a loss of oxygen being effected by heating, a decided absorption took place, and that this absorption, as in the case of No. 1, was augmented by raising the temperature. On examining three other of the oxides (Nos. 6, 8, and 2) a similar change was found to have taken place; they all now gained oxygen on being heated, although when first prepared they had most decidedly lost some under similar circumstances. These experiments are given below in Table IX., together with the results obtained soon after the preparation of the oxides.

It will here be seen that the least time in which this alteration in behaviour of an oxide was observed is in the case of No. 8, where only fourteen days had elapsed between the two sets of experiments. This case, however, is the only one out of the four given on which little or no reliance can be placed, since the evidence of the final absorption of oxygen depends here on a single experiment. This is particularly unfortunate, since the change observed in this case is greater than in any other, in addition to which this specimen was an exceptional one, it having been kept in the moist condition throughout the time of change. In the other three cases the oxides, though hydrated, were mechanically dry and had been kept in bottles with greased stoppers, so that no loss or gain of moisture could have occurred; that such a gain or loss, however, had not occurred was proved in each case by a separate analysis. In the case of No. 2 the date of its preparation was unfortunately unknown. The experiments with it, however, would lead us to conclude that the first investigation of it was not made long after its preparation, and they also render it probable that the opposite was the case with No. 1, and that this oxide also, if it had been examined at an earlier date, would have lost and not absorbed oxygen.

All these experiments, therefore, prove conclusively that hydrated oxides of manganese undergo a gradual molecular change, which entirely alters their behaviour when heated.

§ IX. *Ignition of Oxides.*

In performing the analyses of the above oxides the method of operating necessitated the ignition of the substance so as to expel the water present (see § II.). In order to ascertain the weight of the ignited oxide quickly, and therefore more accurately, three weighings were generally made, the last of which showed as a rule that a constant weight had been obtained before the second one; and in operating in this way it was found that the oxide thus formed was remarkably constant in composition,

Table IX.

Experiments illustrating the Alteration Produced by Time.

Oxide.	Date of Experiments since the preparation of the Oxide.	Conditions of Experiment.	Percentage of MnO_2 found, calculated on the unheated Oxide.		Percentage Alteration in the MnO_2 found.
84. No. 4	Same day	Before heating	4·102	(See Table V.)	
87. ,,	,,	After heating at 100° C. ..	3·993	,, ,,	2·657 loss
67. ,,	20 days	Before heating	61·545	(See Table IV.)	
70. ,,	,,	After heating at 100° C. ..	60 032	,, ,,	2·458 loss
123. ,,	58 days	Before heating	61·632		
124. ,,	,,	,, ,, ...	61·301	61·538	
125. ,,	,,	,, ,, ...	61·511		
126. ,,	,,	After heating at 100° C. ..	62·892		
127. ,,	,,	,, ,, ,, ..	63·253	63·086	2·498 gain
128. ,,	,,	,, ,, ,, ..	63·213		
78. No. 6	2 days	Before heating	85·149	(See Table IV.)	
80. ,,	,,	After heating at 100° C. ..	84·242	,, ,,	1·065 loss
82. ,,	,,	,, ,, 200° C. ..	83·621	,, ,,	1·795 loss
129. ,,	80 days	Before heating	85·001	85·140	
130. ,,	,,	,, ,, ...	85·280		
131. ,,	,,	After heating at 100° C. ..	85·306	85·344	0·24 gain
132. ,,	,,	,, ,, ,, ..	85·382		
133. ,,	,,	,, ,, 165° C. ..	85·603	85·737	0·701 gain
134. ,,	,,	,, ,, ,, ..	85·871		
135. ,,	,,	,, ,, 190° C. ..	85·973	86·088	1·114 gain
136. ,,	,,	,, ,, ,, ..	86·203		
98. No. 8	4 days	Before heating	13·107	(See Table V.)	
101. ,,	,,	After heating at 100° C. ..	11·989	,, ,,	8·53 loss
137. ,,	18 days	,, ,, ,, ..	13·596		3·73 gain
35. No. 2	*x* days	Before heating	45·993	(See Table II.)	
37. ,,	,,	After heating at 100° C. ..	45·687	,, ,,	0·665 loss
39. ,,	,,	,, ,, 183° C. ..	45·526	,, ,,	1·015 loss
138. ,,	*x*+487 days	Before heating	45·899		
139. ,,	,, ,,	After heating at 100° C. ..	46·407		0·900 gain
140. ,,	,, ,,	,, ,, 195° C. ..	47·589		3·47 gain

although no attempt was made in order that it should be so. From 0·2 to 0·5 grm. of substance (after ignition) was used in each analysis, and the ignition was performed in a thin platinum dish over an ordinary Bunsen's burner. The percentages of manganese found in these ignited oxides in the various analyses are given below :—

Gas at Day Pressure.		Gas at Night Pressure.	
141.	69·958	153.	71·758
142.	69·827	154.	71·650
143.	69·849	155.	71·010
144.	69·717	156.	73·061
145.	69·688	157.	71·040
146.	69·903	158.	70·353
147.	69·751	159.	74·997
148.	69·693	160.	72·003
149.	69·790	161.	72·488
150.	69·831	162.	71·277
151.	69·926	163.	70·416
152.	69·901		
Mean ..	69·8195	Mean ..	71·823

The numbers in the first column were obtained when the gas was turned on at the day pressure, and the percentages formed in this case show an extreme variation of 0·27 per cent, all the results indicating that the oxides had been reduced somewhat beyond Mn_2O_3, which contains 69·592 per cent of manganese. With the gas at the right pressure the results obtained were not nearly so regular, the mean of the eleven numbers given here being 71·823, among which Nos. 156, 159, and 161 show that the oxides may in this way be reduced further than Mn_3O_4, which requires 72·03 per cent of manganese, probably owing to the permeability of heated platinum to reducing gases as indicated above.

§ X. *Comparison of the above Results with the Work of other Chemists.*

My original statement made in a paper above alluded to (*Journ. Chem. Soc.*, 1879, 659) that these oxides of manganese lost oxygen on being heated at 100° or 250°, was in direct opposition to the experience of Wright and Luff on the subject, for they had found that no material loss of oxygen took place at 200°. Their actual determinations, however, scarcely warranted such a conclusion, for the numbers given by them show that with one oxide a loss of as much as 2·6 per cent of the total available oxygen present had been effected by the heating; the other specimen examined by them experienced no loss of oxygen at 200° in air, nor at 250° C. in a vacuum produced by a Sprengel pump.* In a subsequent publication (*Jour. Chem. Soc.*, 1880, 25) Wright and Menke contradict these results and confirm my statement that a loss of oxygen does take place at 210° C. Of two samples prepared from potassium permanganate and nitric acid containing potash as an impurity, the first lost 2·95 per cent of its total available oxygen, and the second lost 2·90 per cent. A specimen prepared by the ignition of the nitrate of manganese, lost no oxygen at 210° C., although being much richer in oxygen than the first two, it might have been expected to lose more than they did; the explanation, however, of its not doing so lies, no doubt, in the fact that it contained only 1·14 per cent of water, whereas the others contained 5·27 and 11·56 per cent respectively. None of these oxides suffered any appreciable loss of oxygen at 100° C.

Veley (*Journ. Chem. Soc.*, 1880, 581), experimenting on two samples of pure manganese oxide, in which—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = 5,$$

and which after dryings at 30° to 40° C. contained 10·61 per cent of water, found an absorption of oxygen to take place, beginning at 130° to 140° C. and ending at 160 C.; this absorption increased the available oxygen present by as much as 10 per cent of its original amount. When the oxide was heated in oxygen instead of air, a gain of 15 per bent of available oxygen was observed taking place between 90° and 180° C. Veley thinks it probable that the gain of oxygen is not dependent on the accompanying loss of water.

In the paper above alluded to I state that the pure oxides examined did not become anhydrous after prolonged heating at 200° C., but retained at this temperature from 3 to 6* per cent of water. Wright and Luff did not recognise the retention of any water at 200°; but subsequently Wright and Menke ascertained that a certain amount of water was retained at 210° by each of the three specimens which they examined, the amounts being 0·86, 1·98, and 0·70 respectively. From 3 to 10 per cent of water was retained after drying at 100° C. Veley found that his oxides, when heated at 200° to 250° C. till constant in weight, retained 1·69 per cent of moisture, and again, in another experiment, when heated at 200° C., they retained about 2 per cent. All these numbers agree with my results in showing that the amount retained varies with different oxides, but differ from them in showing the retention to be far smaller than mine do. This difference is easily explained by the fact that Wright and Veley heated their oxides in a current of carefully dried air, whereas in my experiments the heating was performed in an ordinary air-bath where the air would be partially moist, my object not being to ascertain whether an oxide could by any possibility be dehydrated at these temperatures, but to prove the necessary inaccuracy of certain results obtained by Fisher.

§ XI. *Summary.*

In conclusion it will be well to summarise briefly the more important facts indicated by the above experiments.

1. A perfectly pure hydrated manganese oxide may be obtained by decomposing manganese sesquichloride with excess of water; this oxide, however, by no means contains the amount of oxygen theoretically contained in the dioxide.

2. In the oxides investigated, both pure and impure, the manganese present as dioxide bore to that present as monoxide ratios varying between 0·494 and 7·423, and they all (eight in number), with one exception, experienced an alteration in composition when heated to 100° or 200° C. In 6 out of the 7 cases this alteration was due to an evolution of oxygen; in the seventh case, to an absorption of that gas.

3. In all the cases investigated, where any change took place at 100°, this change was increased at 200° C.: but beyond this the extent of the loss at 100° C. does not afford any criterion as to what the loss at higher temperatures will be.

4. The results obtained with oxide No. 1, where experiments were made at six different temperatures, when represented diagrammatically form a curve of considerable regularity.

5. The composition of the oxide taken appears by no means to be the main factor in determining its behaviour on heating: the poorest oxide was not the one which experienced the greatest gain, nor was the richest oxide the one which experienced the greatest loss.

6. The amount of the alteration produced by heating appears to be greatly dependent on the amount of water present in the sample. The only oxide which experienced

* The first of these oxides was prepared by the action of bromine of manganous hydrate precipitated by soda and contained—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = 4{\cdot}5.$$

The second by boiling nitric acid and permanganate, and contained—

$$\frac{\text{Mn as } MnO_2}{\text{Mn as MnO}} = 6.$$

Both of them probably contained a considerable amount of alkali (see *Journ. Chem. So .*, 1880, 25)

* 6 per cent was an extreme case; the average amount retained was about 4·1 per cent.

no change was the only one which was nearly anhydrous. The amount of change, however, even with oxides not differing much in composition from each other, is not entirely dependent on the amount of water present (*c.f.* oxides Nos. 4 and 5).

7. The oxides in which by far the greatest loss of oxygen took place on heating were those examined at once after their preparation and while still in an undried condition.

8. In the one case, however, where the same oxide was examined both before and after being dried, the loss experienced at 100° C. was found to be practically identical.

9. Whatever alteration took place was found to be practically complete in between half an hour and an hour and a half after the oxide had become mechanically dry.

10. Oxide No. 1 experienced no alteration on being kept in boiling water for some hours.

11. On repeatedly moistening and heating the oxide No. 1 the gain of oxygen at 100° C. was greatly increased. This increase depended on the number of times which the operation was repeated, amounting to seven times its original amount when repeated nineteen times.

12. The oxide No. 1, when heated at 100° in dry air, absorbs five times as much oxygen as when heated at the same temperature in air of 1·60 hygrometric state.

13. In the case of oxide No. 5 a considerable loss of oxygen was observed when heated in boiling water, this loss being complete in two and a half hours.

14. When No. 5 was heated at 100° C. in dry air instead of in partially moist air, the loss of oxygen was nearly doubled.

15. The oxides of manganese appear to undergo a molecular change on being kept in air for some length of time, whereby their behaviour on being heated is entirely reversed, a gain of oxygen instead of a loss taking place. This molecular alteration is unaccompanied by any change in composition. It was observed in four separate cases: the smallest time in which it had been observed to have taken place being (with the exception of the unreliable case of No. 8) fifty-eight days.

16. On heating small quantities of manganese oxides in a platinum dish over a Bunsen burner, the oxides obtained were found to be remarkably constant in composition, always containing rather more manganese than the sesquioxide does when the gas was at the day pressure. With a larger supply of gas less constant results were obtained, and some of these showed that a reduction considerably beyond Mn_3O_4 could in this way be obtained.

17. The experiments of Wright and Menke and of Veley agree with the present results in showing that a loss or gain of oxygen takes place at about 200° C., but they fail to show any alteration at temperature as low as 100° C. (the heating being performed in air).

18. Their experiments taken together show that the oxygen value is not in the main dependent on the richness of the sample taken, for the richest specimen suffered no loss at all at 210°, while poorer ones lost nearly 3 per cent of their total available oxygen.

19. The fact that the richest specimen lost no oxygen is probably due to its being nearly anhydrous.

20. The amount of water retained by the oxides at 100° and 200° C. is very variable; that retained in drying them in partially moist air at 200° C. is, according to the present experiments, 3 to 6 per cent; according to other authorities, the use of a current of perfectly dry air reduced it to 0·7 to 1·7 per cent.

Theory of Thermo-electric Motive Forces.—M. Pilleur.—The author suggests that the motor force of a thermo-electric element is proportional to the difference of the coefficients of thermic conductibility, under the influence of the temperature of the metals composing this couple, and to the difference of temperature of the point where the metals are soldered together and of the rest of the circuit.—*Les Mondes.*

ANALYSES OF RICE SOILS FROM BURMAH.

By R. ROMANIS, D.Sc., Chemical Examiner, British Burmah.

The analyses of rice soils was undertaken at the instance of the Revenue Settlement Survey, who wanted to know if the chemical composition of the soil corresponded in any way to the valuation as fixed from other evidence. It was found that the amount of phosphoric acid in the soil in any one district corresponded pretty well with the Settlement Officers' valuation, but on comparing two districts it was found that the district which was poorer in phosphoric acid gave crops equal to the richer one. On enquiry it was found that in the former the rice is grown in nurseries and then planted out by hand, whereas in the latter, where the holdings are much larger, the grain is sown broadcast. The practice of planting out the young crops enables the cultivator to get a harvest 20 per cent better than he would otherwise do, and hence the poorer land equals the richer.

The deductions drawn from this investigation are, first, that, climate and situation being equal, the value of soil depends on the phosphoric acid in it; and, second, that the planting-out system is far superior to the broadcast system of cultivation for rice.

Results of two analyses of soils from Syriam, near Rangoon, are appended.

Soluble in Hydrochloric Acid.

	I.	II. Virgin Soil.
Organic matter	4·590	8·508
Oxide of iron and alumina	8 939	7·179
Magnesia	0·469	0·677
Lime	trace	0·131
Potash	0·138	0·187
Soda	0·136	0·337
Phosphoric acid	0·100	0·108
Sulphuric acid	0·025	0·117
Silica	—	0·005
	14·397	17·249

Soluble in Sulphuric Acid.

Alumina	17·460	15·684
Magnesia	0·459	0·446
Lime	0·286	trace
Potash	0·616	1·250
Soda	0·317	0·285
	19·138	17·665

Residue.

Silica, soluble	11·675	69·546
" insoluble	49·477	
Alumina	3·062	4·178
Lime	0·700	0·134
Magnesia	0·212	trace
Potash	0·276	1·180
Soda	0·503	1·048
	100·000	100·000

These are alluvial soils from the delta of the Irrawaddy.

Hæmo-cyanine and its Distribution in the Animal Kingdom.—C. F. W. Krukenberg.—Both in blue blood, containing hæmo-cyanine and saturated with oxygen, and in the same rendered colourless by reduction, no characteristic distinctions are perceived with the spectroscope. When the hæmo-cyanic blood has been decolourised by carbonic oxide it is quickly rendered blue again if shaken up with atmospheric air.—*Med. Central-Blatt.*

ON THE DETERMINATION OF FAT IN MILK.

By S. P. SHARPLES, S.B.

The following method, first used by myself in 1874, and since followed by most of the chemists in this vicinity, was first published by me in the *Proceedings of the American Academy of Arts and Sciences*, December, 1875. I have found by repeated experiments that this method gives constant results. 5 grms. of the milk are evaporated in a flat platinum dish: the size I have most convenient is 65 m.m. in diameter and 15 m.m. deep. 5 c.c. of milk form a layer over the bottom of this about 2 m.m. thick, and when dry the layer is less than two-tenths of a millimetre thick. The bottom of the dish should be perfectly flat.

If 5 grms. of milk are placed in such a dish, there will first form on the surface a film, and then the drying will go on regularly and result in a honeycomb-like mass on the bottom of the dish. The process of drying will take about an hour and a half, and is best completed by fifteen minutes in the oven at 105° C. The dish is then weighed. It is then filled with petroleum benzine, and allowed to stand under a bell-glass for half an hour: this is then poured off, taking care not to lose any of the upper film, and the dish re-filled; this operation is twice repeated. The dish is then dried at 105° C., and again weighed; the loss gives the fat. The residue is then ignited, and gives the ash. All stirring of the milk before it is dry is carefully avoided.

The following are duplicate analyses made by this method, the sugar being determined by titration. The milk in the second case was seized as adulterated :—

	No. I.		No. II.	
Vol. per cent cream ..	18		6	
Specific gravity	1·030		1·021	
Sugar	4·19	4·19	3·45	3·45
Casein and albumen	5·17	5·23	2·79	2·78
Ash	0·72	0·72	0·47	0·48
Solids not fat	10·08	10·14	6·71	6·71
Fat	4·35	4·35	2·31	2·31
Total solids	14·43	14·49	9·02	9·02

The above form of reporting an analysis I have found is very convenient, and I have adopted regular printed blanks for the same, one of which I enclose. The following analysis is curious, as showing the effects of improper food upon the milk. It was made of milk taken from a herd of about 20 cows which had been fed on "stover corn." "Stover corn" is maize which has been thickly sown. It grows up very rapidly, and consists largely of water. Its use produces a large yield of milk of poor quality.

Milk taken September 6, 1877.

Specific gravity	1·026
Cream	10·00
Sugar	3·86
Caseine	3·31
Ash	0·60
Solids not fat	7·77
Fat	3·07
Total solids	10·84
Water	89·16
	100·00

Boston, Mass., U.S., April 26, 1881.

New Synthesis of Sulph-hydantoine.—R. Andreasch.—This compound can be formed on heating thiaglycolic acid with cyanamide.—*Wiener Anzeiger*, 1880, 84 (22).

ON A PURE COKE.

By W. W. STAVELEY.

I have recently had occasion to test a sample of coke, made from coal-tar pitch, which I found to contain a very small percentage of sulphur. Since it is not generally known that coke of such purity is obtainable in large quantities, it may be well to record the analysis:—

Sulphur	0·12	0·11
Ash	2·43	2·50
Carbon	97·45	97·39 by difference

The sulphur was estimated by the prolonged boiling of the powdered coke, 5 to 6 grms., with nitric acid and a little chlorate of potash. The ash was estimated by heating for several hours in a Fletcher's muffle furnace at a white heat. The sample of coke was taken from the ovens and powdered whilst hot, thus ensuring the absence of moisture. Several determinations of sulphur and ash were made with similar results. A noticeable feature of this coke is that on exposure to the weather, even for months, it does not "slack" or disintegrate. This is no doubt due to the small percentage of sulphur present, the cause of the slacking of most cokes—gas-coke especially—being attributable to the oxidation of the sulphides of iron contained in the coke. The heating and burden carrying power of this coke in the furnace far exceeds that of the best Durham coke. From its hardness and close texture it is especially calculated to resist the action of the hot gases on the upper portion of the furnace, thus diminishing the loss.

LABORATORY NOTES FROM THE UNIVERSITY OF CINCINNATI.

Alkalimetry with Phenol Phthalein as Indicator.

By R. B. WARDER.

The properties of phenol phthalein, including the magnificent red colour which it yields with alkalies, were described by Baeyer* in 1871; but Luck† seems to have been the first to use it as an indicator. With caustic alkalies the delicacy of the reaction is marvellous; but when carbonates are present, the change of colour takes place more gradually, and cold solutions of an acid carbonate are not coloured at all. Even the carbonic acid of the atmosphere may have a marked influence.

For the following experiments a weighed quantity of a dark coloured sample of phenol phthalein from Kahlbaum was dissolved in weak alcohol, and a roughly graduated dropping tube was inserted in the stopper of the flask containing the solution, by which any required quantity of the indicator could be approximately measured out. 0·1 milligrm. of commercial phthalein was added to 100 c.c. distilled water, and $\frac{1}{100}$ normal NaOH solution was run in from a burette. With 0·4 c.c. $\frac{1}{100}$ n. alkali, the colour was barely perceptible; with 1 c.c. it was distinct, with 2 c.c. a beautiful faint pink colour was produced, which deepened to a distinct crimson red with 4 c.c. of the alkali. The colour produced by 1 or 2 c.c. could easily be discharged by shaking with air, and that produced by 4 c.c. was entirely discharged by less of my own breath than a single expiration; indeed, this experiment is well adapted for lecture demonstrations of the carbonic acid of the breath, being much more striking than the usual lime-water test. With different samples of ordinary distilled water, a varying amount of alkali was required to produce the succession of tints above described; the first appearance of colour is often very transient. The least quantity of alkali is required with water from which the carbon dioxide

* *Ber. der. Deut. Chem. Gessell.*, iv., 658.
† *Zeitsch. Anal. Chem.*, 1877, 332.

has been carefully expelled by heat, and it is convenient to have a supply of such water at hand in a well stoppered flask.

As a further test of the delicacy of this indicator, 20 c.c. of ½ normal alkali were carefully neutralised with oxalic acid (with boiling to expel CO_2), then diluted to about 100 c.c., and with the aid of 0·4 milligrm. phthalein a distinct tint was produced by the addition of 1 c.c. of $\frac{1}{10}$ normal NaOH, and a beautiful pink colour by less than 2 c.c. Hence, a variation of less than 0·1 per cent of the whole quantity of alkali used produced a marked change even in very dilute solution; with concentrated solutions the delicacy is much greater.

On adding acid to a cold dilute solution of sodic carbonate we may suppose the first reaction to take place thus:—

$$2Na_2CO_3+C_2H_2O_4=C_2Na_2O_4+2HNaCO_3;$$

and as a solution of $HNaCO_3$ gives no colour with phthalein until it is decomposed by heat, we might expect the reddened solution of a carbonate to be entirely decolourised by ½ equivalent of acid. I have been able to realise this expectation only in part, yet the facts indicated serve as a basis for a method for the estimation of causticity of solutions which do not contain too large a proportion of carbonate. The alkaline solution, with a suitable quantity of phenol phthalein, is mixed with standard acid, in the cold, until the red colour either vanishes entirely, or (if the reaction is lacking in sharpness from the presence of carbonate) until the colour is extremely faint. Of course the solution must be sufficiently dilute to avoid any danger of effervescence in this first titration. The changes of tint closely resemble those observed when a solution of rosaniline is greatly diluted, and it is a valuable aid to the eye to keep such a solution at hand for comparison; and as the depth of colour at this stage varies with the quantity of indicator used, it is desirable to take some definite amount. After completing the first titration, the mixture is boiled thoroughly with successive additions of more acid, until the last returning trace of red colour is discharged by a single drop; or the end may be more quickly reached (in accordance with the law of the "action of mass") by boiling at once with excess of acid, and completing titration with the aid of caustic alkali. The end reaction in this case, which is very sharp, is marked by total discharge of colour.

Let A_1 = the acid required in first titration, and A_2 = that required in the second, with any needed deduction for the alkali used near the end; then A_1+A_2 represents the total alkali; A_1-A_2 represents the caustic alkali; $2A_2$ represents the carbonate.

The following titrations were made to test this method. Solutions used were:—(A) Oxalic acid, 0·991 normal; (B) standard sodic carbonate, ½ normal; (C) sodic hydrate, nearly ½ normal. 0·2 milligrm. phenol phthalein was used in each case.

The caustic soda was prepared by dissolving metallic sodium in water from which the carbon dioxide had been expelled. It was kept in a vessel provided with soda-lime ventilator, and was drawn without contact with the laboratory atmosphere, through the lower end of an ordinary burette, which was also provided with a soda-lime ventilator at the top.

Notwithstanding these precautions, a trace of carbonate appeared to be present in solution C, or to be formed during titration; for 42·22 c.c. of C were exactly decolourised in the cold by 21·39 c.c. of A; on boiling, the colour returned, and a further addition of 0·06 c.c. of the acid was required. By the formula given above, the caustic alkali present represents 21·39 − 0·06 = 21·33 c.c. of A, or 21·14 c.c. of perfectly normal acid. Hence we may assume that its strength in NaOH is 1·0014 × ½ normal with an admixture of Na_2CO_3 in the quantity used, equivalent to 2 × 0·06 = 0·12 c.c. of normal solution. Various mixtures of B and C were then titrated in the same manner. The following table expresses the volumes of these solutions used, as measured from burettes. A_1 is the quantity of acid required in the first titration, A_2 is the additional amount required when the solution was boiled:—

	B.	C.	A_1.	A_2.	A_1+A_2.	A_1-A_2.	$2A_2$.
(1.)	2·53	41·70	21·71	0·69	22·40	21 02	1·38
(2.)	4·90	39·65	21·33	1·30	22·63	20·03	2·60
(3.)	9·84	38 04	21·74	2·56	24·30	19·18	5·12
(3′.)	,,	,,	21·80	2·50	,,	19·30	5·00
(4.)	10·61	38·23	22·12	2·64	24·76	19·48	5·28

The following table shows the total alkali, the caustic alkali, and the carbonate taken, as represented in columns B and C, together with the corresponding quantities found by means of A_1+A_2, A_1-A_2, and $2A_2$. For convenience, these quantities are not calculated by weight, but are represented in c.c. of normal solution, as the object is merely to exhibit the experimental errors incident to this method. It is allowable to assume, in calculating these results, that each portion of C used contained the same quantity of Na_2CO_3 that was found in the preliminary titration:—

	Total Alkali.		NaOH.		Na_2CO_3.	
	Taken.	Found.	Taken.	Found.	Taken.	Found.
(1.)	22·25	22·20	20·86	20·83	1·38	1·37
(2.)	22·41	22·43	19·84	19·85	2·57	2·58
(3.)	24·08	24·08	19 03	16·01	5·04	5·07
(3′.)	,,	,,	,,	19·13	,,	4·96
(4.)	24·55	25·54	19·13	19·30	5·42	5·23

Two values of A_1 and A_2 are given for the third experiment. Those in line (3) correspond to a reading taken while there was still a faint reddish tinge, while (3′) represents a complete discharge of colour in the first titration. The difference is not great, but a little practice will enable the operator to obtain still closer results. In experiment (4) the colour was quite inappreciable when the reading was taken; and the result shows that A_1 was rather too large and A_2 too small.

The use of phenol phthalein as an indicator, so strongly recommended by Luck, seems to have been somewhat neglected in consequence of the very property which is the basis of the method just described for distinguishing alkalinity and causticity. I think the convenience and accuracy of the new method will recommend it to those who have occasion to make such determinations; but, as its capabilities are not yet exhausted, I hope to continue the investigation, and ascertain whether the plan can be modified for the detection and estimation of carbonic acid in general.—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, May 14th, 1881.

Professor FULLER in the Chair.

NEW Members:—Mr. D. J. Blakely and Mr. Walter Kilner.

Prof. G. C. FOSTER read a communication from Prof. ROWLAND and Mr. E. H. NICHOLS, of Baltimore, U.S., on "*Electric Absorption in Crystals.*" According to the theory of Clausius, Maxwell, and others, there should be no electric absorption in the case of perfectly homogeneous substances. Prof. Rowland tested this deduction in the case of glass,—which is not quite homogeneous—quartz, and calcite. This was done by placing the material as the dielectric in a condenser formed of two amalgamated copper plates. The condenser was charged by six Leyden jars, and the absorption measured by a quadrant electro

meter. The results were that quartz had about one-ninth the absorptive power of glass, and calcite none at all.

Dr. Hopkinson said that the *kind* of glass was important, and threw doubts on the theory that the absorption was due to heterogeneity. Paraffin wax had little absorptive power, and yet was very heterogeneous.

Professors Perry and Ayrton thought that two non-homogeneous substances in combination might have no residual charge.

Mr. Lewis Wright suggested that the optical character of crystals should be considered in these experiments which might be extended to other crystals. Calcite is uniaxial.

Prof. Minchin, of Cooper's Hill Engineering College, described his new absolute sine electrometer. This consists of two metal plates, in one of which is an aperature nearly closed by a metal trap-door suspended from the plate by two fine platinum wires, and resting against fine stops when the plates are hung vertically. These plates are connected to the poles of the cell to be measured, and tilted out of the vertical till the attraction of the whole plate on the suspended trap or shutter is just balanced by the weight of the latter. The electromotive force is then proportional to the line of the angle of displacement.

Dr. Lodge remarked, that the apparatus combined sensitiveness with practicality. The E.M.F. of a single cell could be measured by it, whereas Thomson's absolute electrometer could only give the total of a number of cells.

Prof. Ayrton stated, that he and Prof. Perry hoped to modify the instrument in the direction of sensitiveness by adding another plate and giving it a high charge.

Dr. Coffin suggested reversing the process by taking an observation.

Prof. Foster read a paper by Dr. J. E. Mills, "*On the Ascent of Hollow Glass Bulbs through Liquids.*" A glass ball of a pear shape rises through a liquid with a sensibly uniform velocity, which varies with the liquid. The time of ascent is proportional to the square of the diameter of the vessel, and depends of course on the specific gravity of the contents of the bulb. Dr. Mills measures the densities of gases and liquids in this manner.

Prof. Perry thought that the bulb should be of a shape having no re-entrant angles.

CORRESPONDENCE.

ESTIMATION OF FAT IN MILK.

To the Editor of the Chemical News.

Sir,—I have read with interest Mr. Carter Bell's reply to Mr. Hamlet's process for the Estimation of Fat in Milk. I quite agree with Mr. Bell, that it is *rather* ingenious, but extremely tedious (if not to say an extravagant process, certainly unnecessarily destructive), and in my opinion, there is more room for error in manipulation than in that of Wanklyn's. As regards the process described by Mr. Bell it is very accurate when carefully conducted, but the flasks are of so inconvenient a size that I shall now describe the process I have been in the habit of using, and in which is combined the common extraction method recommended by Mr. Hamlet, also the digestion by Mr. Bell. The plan I adopt is as follows:—10 grms. of milk are evaporated in a platinum boat (of suitable construction), to near dryness (to complete dryness if you wish to determine the total solids) in the water-bath; the boat is now inserted into the extraction tube (which is plugged with a little cotton-wool and contains a stopper in the narrow part of the tube), and then connected to an upright Liebig's condenser. A small tared flask is now fixed on to the end of the extraction tube (50 to 100 c.c. capacity) containing ether. The ether is evaporated by means of hot water, and when sufficiently condensed in the tube above, so as to completely cover the platinum boat, the stopper of the extraction tube is turned and the ether allowed to remain for about 6 hours or all night if convenient. All that now remains to be done is to cautiously open the stopper and allow the ether and oil to flow into the tared flask; boil the ether repeatedly until extraction is complete. Disconnect the flask, evaporate the ether dry, and weigh the oil. The platinum boat may also be taken from the extraction tube, dried in water-bath, and weighed, which will give the solids not fat, then ignited and weighed, and we have the ash. If there is any doubt in the mind of the operator, that the ether has not been able to penetrate the residue, after there have been several extractions made, the boat may be withdrawn from the extraction tube, the residue detached from its sides by means of a small platinum spatula, and the whole again returned to the extraction tube, and the operation of extraction repeated. When the extraction has been conducted as described, there is no fear of any fat being left undissolved in the residue. The following duplicate analyses are the results I have just obtained from a sample of milk I have reason to believe is genuine or unadulterated. The amount of milk operated upon was 10 grms. Specific gravity, 1027·3.

Total solids	10·2440	10·2448
Fat	1·9940	2·0001
Solids not fat	8·2500	8·2447
Ash	0·6940	0·696c

—I am, &c.,

William Johnston, F.I.C., F.C.S., &c.

Kings Lynn, May 11, 1881.

ESTIMATION OF FAT IN MILK.

To the Editor of the Chemical News.

Sir,—The methods for estimating fat in milk described by Mr. Hamlet in the Chemical News (vol. xliii., p. 170), and by Mr. J. Carter Bell on p. 194 of the same volume, are no doubt good and reliable; but for expedition and ease of execution they both, to my mind, must give place to extraction on Soxhlet's fat extractor, and I doubt whether they will give more accurate results.

If the small platinum basins are made of an oval shape they can be placed in the extractor, and when once the process has been started it can be left to go on for an almost indefinite time. To those whose duties frequently call them elsewhere, so that they cannot remain in the laboratory at all times, what can be more convenient than that they should be able to start the extraction before leaving, and return to find it finished?—I am, &c.,

Alfred Ashby, Public Analyst.

Grantham, May 10, 1881.

THE ESTIMATION OF PHOSPHORUS IN STEEL.

To the Editor of the Chemical News.

Sir,—Mr. J. Oliver Arnold, in his reply (Chemical News, vol. xliii., p. 209) to my criticisms of his paper, "On the Estimation of Phosphorus," gives some further details respecting his mode of operation. He has only himself to thank, if, in their absence, his results were apt to be misconstrued.

Mr. Arnold believes that a pyrophosphate would "undoubtedly" suffer complete conversion into orthophosphate, by evaporating its solution to a low bulk with hydrochloric acid. I am not prepared to deny that such would be the case, but I have my doubts, which will probably be shared by other chemists.

Similarly, it must be held that 50 c.c. of molybdic acid solution would be ample, and that because it cannot be correctly described in the words of Mr. Arnold as "a moderate excess."

The main point of Mr. Arnold's letter seems to be that his paper was intended to show that the molybdic acid method was untrustworthy, if certain well-known precautions were neglected, and that if these be adhered to, the method is so lengthy as to be of no practical value.

The correctness of the first part of this contention required no demonstration. The second part ignores the very essence of the process, which is not the rapidity with which results are obtained so much as the large weight of precipitate yielded by a minute quantity of phosphorus. Mr. Arnold says, "'Phosphorus' assumes that I get down the correct weight of the definite salt of phosphorus, and convert it into the magnesia salt, whereas I distinctly stated that the solution was boiled, and free molybdic acid obtained in addition to the phosphomolybdate." If Mr. Arnold will take the trouble to read my letter a second time, he will see that I referred to his first experiments, and that my general position is as follows :—

1. Eggertz's molybdic acid method gives accurate results when the necessary precautions are observed.

2. Mr. Arnold obtained low results because he neglected some of these precautions.

3. The value of Eggertz's method is that 1·63 m.grm. of phosphorus yield 100 m.grms. of precipitate.

4. Mr. Arnold sacrifices this advantage, and prefers to convert the phosphorus into 5·9 m.grms. of a precipitate which is not insoluble in the solutions employed. In this he errs in very good company, as exactly the same plan has been previously proposed by at least half-a-dozen other chemists.—I am, &c.,

Phosphorus.

May 14, 1881.

THE SO-CALLED "BUNSEN" PUMP.

To the Editor of the Chemical News.

Sir,—The letter of Dr. H. Sprengel on the above subject appears to me open to a little discussion, and especially on the subject of the credit due to the discoverer of a scientific principle and its application to the construction of a certain form of scientific apparatus, and that due or accorded to one who with far-sighted experience adapts such scientific principle or apparatus to the working of a process successfully, hitherto a faulty or deficient one.

Such an adaptation itself may be a work of genius, nay, it may be one only likely to occur to the mind of one, already possessed of a fund of experience in his own peculiar branch, possessed by no other living man.

Such adaption of a principle, to push the case somewhat farther, might be, in fact, a distinct benefit to mankind, in which case, certainly not so much the discoverer of the principle as the one who applies and adapts it to its widest range of usefulness, will be the one who will receive the grateful acknowledgments of the largest number, and this is but natural.

It would, from the foregoing, appear, then, that Prof. Roscoe, in using the words " to him (Bunsen) we are also indebted for the apparatus for accelerating filtrations, the Bunsen pump, &c.," was referring not to Sprengel's principle of the production of a vacuum by the flow of various liquids down specially constructed tubes, nor to his water-air-pump itself, but to Bunsen's filtering apparatus as a whole, in which the water-air-pump arrangement, confessed by Sprengel himself to be a comparative failure as an air-pump, is applied and combined so as to give a filter-pump which has been a brilliant success. The phrase employed by Dr. Sprengel in his letter,—" the satisfaction of being credited with having placed a useful servant at the disposal of Science and Industry "—is not quite free from objection, for as regards the water-*filter*-pump, to credit Dr. Sprengel with this would be a clear injustice to Bunsen. It was, in fact, Bunsen who adapted Sprengel's principle to the construction of this *filter*-pump and its appliances, and therefore it is Bunsen who deserves the thanks, so far, of Science and Industry, and it is natural that Bunsen's name should come to adorn this form of filtering apparatus. Sprengel conceived a general principle, and applied it with great success to the construction of a mercury air-pump, but the water-air-pump invented on the same principle was laid aside as a non-success, and nothing was done with it. Bunsen took it up, and adapted it to a new purpose, a new mode of filtration, and with every success, and the benefit he thus conferred being universal, he has earned universal gratitude, and his name has been affixed to the appliance. Thus Bunsen is much more than an "*employer*," he having adapted an instrument, so far without practical use, to a great and useful purpose. Bunsen also acknowledges the discovery of the principle, and also both mercury and water air-pumps fully enough, and no doubt all chemists do, and what more can be asked? If Dr. Sprengel's arguments were applied to the work of chemists, then in cases where a chemist discovers a new substance, but a technologist applies the same successfully for the first time, then the chemist should feel aggrieved, and contest the right of enjoyment of popular credit with the technologist or manufacturer who has applied it.

No one speaking of the Sprengel water air-pump, which as an air-pump was laid aside, could ever term it Sprengel's filter-pump without injustice to Bunsen; or were it generally stated that filtrations are made with the aid of Sprengel's pump, Bunsen's ingenious adaptation—in fact, invention—would be unjustly ignored thereby. Since without its application to filtering the water air-pump would have lain useless, this application is its most important feature, and the fact sufficiently explains the naming it as Bunsen's filter-pump or Bunsen's pump, in which no special merit is dreamt of merely as an air-pump and apart from its aid in filtration. I imagine, finally, every chemist knows well enough that the principle of rarefaction by means of the stream of water is due to Sprengel, and the application of the not too excessive exhaustion to the procees of filtration is Bunsen's, and this happening to be the cardinal virtue of the arrangement, the appliance is termed Bunsen's filter-pump.

With regard to the term "*Hero worship*" as applied to the "enumeration of the works of his friend Prof. Bunsen, by Prof. Roscoe in an an article in *Nature*, under the heading 'Scientific Worthies.'" As an old pupil both of Prof. Roscoe and Prof. Bunsen, I beg to protest against the use of such a term as exceedingly unjust and totally unfounded. Though it might perhaps, in some cases, be a little too much for the self control of some scientific worthies to recount the benefits conferred on science by their labours during their lifetime, in the case of Bunsen this is not so. Here is given a kindly tribute of friendship and respect for a man, than whom no other, perhaps, who has yet lived amongst men of science, has shown such an unselfish disregard for his own fame or standing in the opinions of the outside world, who has been so tardy in, or held back so much from, publication, or who has devoted so much of his best energies to the instruction and scientific welfare of his pupils.

Recollecting Bunsen for a moment, in his lecture-room in Heidelberg, and his unassuming, quiet demeanour there and in his laboratory, and his complete devotion there to the welfare, and indeed comfort and happiness, of his pupils, and the affectionate regard and esteem in which they hold him, and, finally, his numberless contributions to chemical and physical science, and then mindful of Prof. Roscoe's kindly tribute as an old friend and pupil, I am assured the great majority of Bunsen's host of past and present pupils would say, "It is all true, and even much is still left unsaid;" and as to the term "*Hero worship*," this sounds in connection therewith simply unmeaning. The rendering by one eminent man of science a tribute of friendly and grateful testimony in acknowledgment of quite exceptional claims of another,—in the present case of one with the most devoted and unselfish nature ever known amongst scientific men or great teachers of science—is an act simply indicative of an open and outspoken nature, willing and

large minded enough to see and acknowledge what is good and great in others. Such a tribute comes all the more gracefully, however, from an old friend and pupil of Bunsen's, now the President of the Chemical Society of London, and here the stigma of "Hero worship" must fall completely to the ground.—I am, &c.,

VERAX.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 14, April 4, 1881.

Alcoholate of Chloral.—M. Berthelot.—A thermic study, with especial reference to the heat liberated by the union of alcohol to chloral when this compound is formed in its three states, solid, liquid, and gaseous. In all these conditions the heat thus developed is greater than the corresponding heat of chloral hydrate.

Lightning without Thunder.—M. d'Abbadie.—The author describes a phenomenon of this kind which he witnessed in Africa when a thin fog occupying a narrow valley was suddenly illuminated by sheet lightning. He points out that in this case the ordinary explanation of so-called "heat lightning" as the mere reflection of a storm below the horizon is inapplicable.

Compounds of Phthalic Anhydride with the Hydrocarbons of the Benzol Series.—C. Friedel and J. M. Crafts.—The authors have in this manner obtained ortho-benzoyl-benzoic acid, para-toluyl-ortho-benzoic acid, and duroyl-benzoic acid.

An Account of Chalcomenite, a New Mineral Species.—MM. Des Cloizeaux and Damour.—This mineral, a copper selenite, is found in the mountains of Cacheuta, ten leagues to the south-west of Mendoza, in the Argentine republic, in company with selenides of lead, silver, and copper, differing greatly in their composition.

Researches on the Change of State in the Neighbourhood of the Critical Point of Temperature.—L. Cailletet and P. Hautefeuille.—The authors remark that near the critical point there are witnessed for very slight variations of temperature, phenomena which have led Andrews to regard the gaseous and the liquid states as distant terms of one and the same state of matter, which may pass from one to the other by a continuous series of changes. It is impossible to know what is the state of the matter which gives rise to the moving and wavey striæ which displace each other above the mercury on operating in the vicinity of the critical point. A slow decrease of pressure often shows if a tube is filled with a liquid or a gas, for in the latter case the release gives rise to a general mist and to liquid drops; but this procedure furnishes no clue to the nature of these striæ. The authors have overcome this difficulty by colouring carbonic acid with the blue oil of galbanum. They have found that these undulating striæ dissolve the oil, and are consequently produced by liquefied carbonic acid. They conclude that matter does not pass by insensible degrees from the liquid to the gaseous state.

Bismuthine Produced by Burning Coal-Mines.—M. Mayençon.—The author has obtained this mineral from the burning mines of Rosier, Montrembert, and Chavassieux. He has not been able to find it in the surrounding rocks, and suggests that it may have its origin in nodules of iron carbonate.

Change of Volume accompanying the Galvanic Deposition of a Metal.—E. Bouty.—The author has previously shown that galvanic deposits experience a variation of volume, whence results a pressure exerted upon the mould which receives them, and secondly that Peltier's phenomenon is produced at the surface of contact of an electrode and an electrolyte. He now finds that these two phenomena are connected, and that the first is a consequence of the second.

Viscosity of Gases.—William Crookes.—This memoir will be found in full in a forthcoming number of the *Annales de Chemie et de Physique*, and also in a forthcoming number of the *Philosophical Transactions*.

Luminous Intensities of the Radiations given off by Incandescent Platinum.—J. Violle.—If we take as unity the luminosity of incandescent platinum at 954°, at 1775° it is = 507.

Voltaic Conductivity of Heated Gases.—R. Blondlot.—According to the author's experiments there can be no doubt as to the voltaic conductivity of hot gases, even at temperatures much below redness, *e.g.*, at 60° to 70°. The current was obtained from a battery of five Bunsen elements.

Internal Discharges of Electric Condensers.—E. Villari.—The author's conclusions are that the heat evolved by the internal discharge may be neglected in case of feeble discharges; beyond certain limits it manifests itself and increases very rapidly with the discharges themselves; thus the first means to augment this internal heat is to make use of jars charged to a very high potential. The internal discharge is sensibly augmented if the exterior spark is produced between two small balls of 20 to 30 m.m. in diameter; it decreases, on the contrary, by almost one-half if the spark is taken from a point and one of the balls. The inverse is the case for the heat produced by the external exciting spark. For a given charge the internal discharge increases if the inner coating of the jar is diminished.

"Magic Mirrors."—L. Laurent.—The author states that a common silvered mirror, plane, convex, or concave, may be rendered very magical, and describes certain experiments in support of his assertion.

Sodium Hydrosulphite.—P. Schützenberger.—The author combats the views of M. A. Bernthsen on the composition of this salt.

Certain Novel Processes for Desulphurising Alkaline Solutions.—M. Scheurer-Kestner.—Not capable of useful abstraction.

Application of Chamber Crystals.—M. Sulliot.—The author finds that this compound, recommended as a disinfectant by MM. C. Girard and Pabst, gives off vapours too irritating for use in hospitals, &c. He proposes to render them supportable by placing the crystals in a porous cylindric vessel, surrounded by a second vessel containing alcohol. Vapours of nitrous ether are evolved.

Secondary and Tertiary Amylamines derived from the Active Amylic Acid of Fermentation.—R. T. Plimpton.—The author finds that between the active and the inactive secondary and tertiary bases there exist very marked differences. The boiling-points of the active bodies seem a little lower than those of the corresponding inactive bodies. Their hydrochlorates are syrupy and very deliquescent, whilst those of the inactive bodies crystallise easily and are not affected by the air.

Action of Phosphorus Perchloride upon Isobutylic Aldehyd.—S. Œconomides.—The principal product of the reaction is isobutylene chloride.

Preparation of Isobutylic Acetal.—S. Œconomides.—The author passes a current of hydrochloric acid into a refrigerated mixture of absolute alcohol and isobutylic aldehyd. The liquid separates into two layers, the upper one being a mixture of isobutylic acetal and chlorethyline.

Products of the Distillation of Resin.—A. Renard.—The author describes a new compound, boiling between 170° and 173°, and represented by the formula $C_{10}H_{10}$.

No. 15, April 11, 1881.

Ethyl Peroxide.—M. Berthelot.—This compound is prepared by passing through anhydrous ether a slow current of oxygen, absolutely dry, and strongly ozonised. The peroxide of ethyl remains as a dense syrupy liquid, miscible with water. If cooled down to −40° it becomes viscous, but does not crystallise. If heated in a glass tube it distils over in part, but the experiment terminates with a sudden and very violent explosion.

Liquefaction of Gaseous Mixtures.—MM. Cailletet and P. Hautefeuille.—In general the assimilation of the solution of a gas to its liquefaction is very imperfect, even in the case where the solution is completely destroyed by the action of a vacuum, for the evaporation-heat of a liquefied gas is always weaker than its solution-heat. We may therefore always suppose a chemical action when a gas dissolves in a liquid, but if this chemical action, as measured by the difference of the two heats just mentioned, is equal to the heat of contraction of the mixture of the two bodies taken in the liquid state, the assimilation becomes perfectly legitimate. The mixture of carbonic acid and cyanogen may be considered as the type of the liquids which the authors have been studying. This mixture preserves its characters at temperatures much higher than that which corresponds to the critical point of its more readily liquefiable element.

Vapour of Ammonium Bisulph-hydrate.—M. Isambert.—This compound is less volatile in presence of its elements than in a vacuum, or in an inert gas, like hydrogen.

Sulphur Chlorides, Bromides, and Iodides.—J. Ogier.—A thermo-chemical study on the formation of these compounds.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 3, January 4, 1881.

New Schemes for Explaining Chemical Reactions.—Dr. Charles Brame.—The author introduces a new notation by which, he states, he has succeeded in attracting the attention of his pupils more perfectly than by the ordinary system. He suppresses the sign = and expresses separation by an arrow, placed horizontally or perpendicularly, and combination by a double-headed arrow. Thus, to explain the decomposition of mercury oxide by heat he writes $(Hg) \rightarrow (\,)$.

No. 4, January 27, 1881.

Arrangements are made for the next meeting of the French Association for the Advancement of Science on April 14, at Algiers.

According to M. l'Abbé Barret the excessive resonance of churches may be diminished at pleasure by stretching iron wires across the dome.

Review of Recent Progress in Chemistry.—M. Gerber.—The author points out several errors and inaccuracies in the views of M. E. Maumené.

No. 5, February 3, 1881.

Werdermann's system of electric lighting has been tried successfully at Paris. The inventor makes use of pencils of carbon, perforated and lined within with an isolating medium.

A telephonic line between Seville and Fregenal, a distance of 150 kilos., has been established and put in successful action.

The Margarimeter.—An illustrated description of a recently-invented instrument for detecting foreign fats in butter. The apparatus is based upon the different specific gravity of butter and of fat. Its zero corresponds to pure butter, and each division above denotes an addition of 10 per cent of fat. The mark 100° signifies pure fat.

Crystallogenic Studies.—M. Charles von Hauer.—Not capable of useful abstraction.

No. 6, February 10, 1881.

This issue contains nothing novel in chemistry.

No. 7, February 17, 1881.

M. E. Hospitalier, in the *Nature Française*, gives an account of a telephone without wires, based upon the reflection of sound-waves.

Relations between the Atomic Weights of the Elements.—Maximilien Gerber.—Inserted at length.

Journal de Pharmacie et de Chimie.
December, 1880.

Plantations of Cinchonas Established by M. Vinson in the Island of Reunion.—The author has succeeded in establishing the valuable species *C. officinalis*, *C. succirubra*, and *C. Calisaya*.

The Spectroscope Applied to Chemistry and Pharmacy.—M. Collier.—A continuation.

Picric Acid and its Antiseptic Properties.—Dr. J. Cheron.—The author recommends picric acid in preference to phenol, since, having no odour of its own, it cannot mask dangerous effluvia.

The Place Occupied by Boron in the Series of Simple Bodies.—A. Etard.—Already noticed.

January, 1881.

On Papaine.—New Contribution to the History of Ferments.—A. Wurtz.—Already noticed.

Volumetric Determination of Butter.—Dr. A. Adam.—This memoir cannot be usefully abstracted without the accompanying illustration.

Treatment of Burns caused by Sulphuric Acid.—M. Alanore.—Two pupils of the Communal School of Clermont-Ferrand were severely burnt in the face with boiling sulphuric acid owing to the rupture of a retort. The author covered their faces with a soft paste made of calcined magnesia and water, and applied it in layers of 2 m.m. in thickness. As portions of the coating split off the paste was re-applied. All pain ceased in about a quarter of an hour, and after some time—five hours in the slighter of the cases, and twenty-four in the more severe—no further treatment was needful. Their faces show no trace of injury.

Determination of Small Quantities of Arsenic, Lead, and Copper in Urine.—M. Reichardt.—The destruction of the organic matter by chlorine is completely to be avoided. The urine is to be acidulated with a few drops of nitric acid, and treated for thirty to sixty minutes with a current of sulphuretted hydrogen till the liquid is saturated, and it is then left to settle in a covered vessel for twenty-four hours, and filtered. From 1 to 2 litres of urine may be employed for the experiment, and should be slightly warmed before introducing the gas. The presence of lead, bismuth, copper, and antimony is very rare; the filter is burnt when completely dry; the ash is melted with a mixture of soda and saltpetre, and the metals are sought for in the residue. For detecting arsenic, as soon as the urine saturated with hydrogen sulphide has been filtered, the filtrate is treated with bromine water, which converts the arsenic sulphide into arsenic acid; the excess of bromine is expelled by the application of a gentle heat, the arsenical deposit is converted into arsenic hydride, which is condensed in a solution of silver nitrate.

Bulletin de la Société Chimique de Paris,
No. 1, January 5, 1881.

Researches on Ozone.—P. Hautefeuille and J. Chappuis.—Already noticed.

Observations on an Iodometric Proceeding.—J. Pellieux and E. Allary.—The authors, in the description of their process (*Bull. Soc. Chim.*, 32, p. 273), speak of a preliminary calcination with soda-lime in cases where the substance analysed contains cyanides and thionic compounds, such as kelp. This calcination should last half an hour at a dull red heat. The quantity of soda-lime employed should be three or four times greater in weight than the sample operated upon. We may be sure that the calcination has been sufficient if an excess of hydrochloric acid, in presence of starch, immediately gives a blue colour. It is necessary, before proceeding to the determination with bromate, to destroy this blue tint, for which purpose a dilute solution of sodium sulphide is used. If traces of iron are present a faint yellow tint may remain after the destruction of the blueness.

Analyses of Sea-weeds.—E. Allary.—The quantity of iodine per 1000 kilos. of weed ranges from 1·224 kilos. to 0·077 kilo.

Sodium Boro-tungstates. — D. Klein. — Already noticed.

A New Organic Acid, the Benzoyl-propionic.—E. Burcker.—The author describes this acid, $C_{10}H_{13}O_3$, and its barium and iron salts.

No. 2, January 20, 1881.

Action of Phosphorus upon Hydriodic and Hydrobromic Acids.—A. Damoiseau.—Already noticed.

Detection of Alcohol in Transparent Soaps.—H. Jay.—It appears that every article manufactured with the aid of alcohol is required on its introduction into France to pay duty on the supposed quantity of this reagent which has been used in its preparation. Certain transparent soaps of German origin are now met with, made, as is alleged, without alcohol, and the author proposes the following process for verifying this statement by ascertaining the presence or absence of alcohol in the manufactured article:—50 grms. of soap are cut into very small pieces and placed in a phial of 200 c.c. capacity; 30 grms. sulphuric acid are then added, and the phial is stoppered and agitated till the soap is entirely dissolved. The phial is then filled up with water, and the fatty acids are allowed to collect and solidify. The subnatant liquid is drawn off, neutralised, and distilled. The first 25 c.c. are collected, filtered, and mixed, according to the process of MM. Riche and Bardy for the detection of alcohol in commercial methylenes, with ½ c.c. sulphuric acid at 18° B., then with the same volume of permanganate (15 grms. per litre), and allowed to stand for one minute. He then adds 8 drops of sodium hyposulphite at 33° B. and 1 c.c. of a solution of magenta, 1 decigrm. per litre. If any alcohol is present there appears within five minutes a distinct violet tinge. The presence of essential oils gives rise to a partial reduction of the permanganate without affecting the conversion of alcohol into aldehyd.

Action of Ethylene Bromide upon Toluene in Presence of Aluminium Chloride.—C. Friedel and M. Balsohn.—The products obtained are a mixture of isophthalic acid with a smaller proportion of terephthalic acid. Phthalic acid is absent.

Action of Sulphuric Acid upon Phenyl-acetylene.—C. Friedel and M. Balsohn.—The result of the reaction is methyl-benzoyl, the action of the sulphuric acid being a simple fixation of water.

Zymometer.—M. Zincholle.—An illustrated description of an instrument for testing the value of a sample of yeast and for examining the progress of fermentation. It is founded on the production of carbonic acid in a given time, which is the consequence of the reduction of maltose. The speed of the fermentation is inversely as the square of the weight of the yeast.

The Fluorine Salts of Tellurium.—A. Högbom.—An account of the potassium, ammonium, and barium salts.

Formation of Free Sulphuric Acid in the Gasteropods, especially in Dolium Galea.—R. Maly.—A liquid secreted by *Dolium Galea* contains 0·98 per cent of free H_2SO_4. Its origin is not explained.

No. 3, February 5, 1881.

Applications of Chamber Crystals.—C. Girard and J. A. Pabst.—The authors defend their proposals for the utilisation of these crystals against the criticism of M. Riche.

Platinous Hypophosphite.—R. Engel.—The author has obtained this compound by the action of hydrogen phosphide upon platinum tetrachloride. It is insoluble in water, alcohol, the hydrochloric, sulphuric, and acetic acids, but is oxidised and decomposed by nitric acid and chlorine water. It is decomposed at temperatures above 100°, giving off spontaneously inflammable hydrogen phosphide.

Detection of "Denaturated" Alcohol.—P. Cazeneuve and S. Cotton.—The authors propose as a reagent for the detection of so-called "methylated spirit," a mille-normal solution of permanganate. This solution is reduced slowly at common temperatures by pure ethylic alcohol, and also by pure methylic alcohol. But it is reduced instantaneously by the foreign bodies which ordinary methylic alcohol always contains.

Waldivine.—C. Tanret.—The author has obtained from the fruit of *Simaba Waldivia* a crystalline compound of the formula $C_{36}H_{24}O_{20}5HO$. It is neutral, non-volatile, possesses no rotatory power, dissolves most freely in chloroform, and is easily decomposed by alkalies.

Russian Chemical Society.—Session April 3/15, 1880, by M. A. Krakau.—M. Potilitzine made a communication on certain double decompositions which take place in the absence of water, proving that the phenomenon of distribution between the reacting bodies is in contradiction with the principle of maximum work, and that it depends on the values of the atomic weights of the metallic elements which take part in the reaction.

MM. Beilstein and Kurbatoff communicated researches on the petroleum of Bakou. They have proved the presence of hexa-hydro-meta-xylene in the portion boiling between 115° and 120°.

M. Latchinoff announces that choleo-camphoric acid if submitted to etherification or heated with sulphuric or hydrochloric acid, loses the elements of water, and is transformed into cholalic acid.

M. W. Alexéeff gave the results of further researches on the liquid camphor discovered by the late M. Wreden.

M. Schœne communicated a paper on the composition of hydrated barium peroxide.

M. Goldstein gave an account of his researches on the oxidation of the acetones.

M. Przybytek expounded his researches on the oxidation of erythrite, and presented a preliminary note on the oxidation of glycerine by means of nitric acid.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome 8, No. 3, November and December, 1880.

This number does not contain any original chemical matter.

Chemisches Central-blatt.
Vol. 11, No. 32.

Carbamid Sulphon-acetic Acid.—R. Andreasch.—This compound is formed by caustiously oxidising sulph-

hydantoine with potassium chlorate and hydrochloric acid.—*Wiener Anzeiger*, 1880, 84-85.

Certain Transformation-Products of Rufigallic Acid and the so-called Oxyquinone.—Jos. Schreder.—On treating rufigallic acid with an excess of melting potassa the author obtained Malin's oxyquinone which, is a diphenyl derivative, along with salicylic, oxybenzoic, oxyterephthalic, and γ-oxyisophthalic acids.

Carbonic-oxide-hæmoglobine.—T. Weyl and B. v. Anrep.—The authors notice that oxidising agents have a much stronger action upon oxyhæmoglobine than upon carbonic-oxide-hæmoglobine.—*Archiv. Anat. and Physiol.*

Molecular Phenomena in Tin and Zinc.—C. Rammelsberg.—Not suitable for abstraction.

Vol. 11, No. 33.

Chemical Constitution of Milk.—MM. Danilewsky and Radenhausen.—Caseine is not a chemical individual, but a mixture of an albumen, probably identical with that of serum, and of certain protalb compounds.—*Schweiz. Ztschr. Pharmacie*, 1880, 22.

Influence of Light on the Transformation of Matter.—M. Speck.—From experiments made upon himself the author finds that the carbonic acid exhaled per minute in the dark and in the light are respectively as 100 : 104. The difference in the consumption of oxygen is merely as 100 : 101.—*Med. Central-Blatt.*

Behaviour of Ammonia in the Human Organism.—M. Coranda.—In man ammonia is transformed into urea, and the human organism, in respect to acids and alkalies, behaves like that of the carnivora.—*Med. C.-Blatt.*

Liberation of Heat during Digestion.—R. Maly.—This paper does not admit of useful abstraction.

Vol. 11, No. 34.

Direct Introduction of Carboxyl Groups into Phenols and Aromatic Acids.—C. Senhofer and C. Brunner.—The authors obtain from pyrogallic acid, by treatment with ammonium carbonate, two acids, the gallocarbonic and the pyro-gallo-carbonic.—*Wien. Anzeiger*, 1880, 93.

Resorcine as a Disinfectant.—J. Andeer.—Pure resorcine in a 1-100 solution completely checks the formation of Schizomycetes and is recommended as a caustic for morbid tissues.—*Med. C.-Blatt.*

Vol. 11, No. 35.

Decomposition of Barium Peroxide in a Vacuum at a Red Heat.—M. Boussingault.—Baryta at 450° and an ordinary pressure absorbs oxygen, and is dissociated in a vacuum at the same temperature.—*Ann. Chim. Physique.*

Products of Roasting Coffee.—O. Bornheimer.—The three chief products are solid fatty acids, caffeine, and caffeol, a heavy oil, which turns yellow on exposure to the air, and which is the vehicle of the aroma of coffee.

Vol. 11, No. 36.

Photo-polymerisation of Vinyl Bromide.—D. Looff.—The author has examined the influence of different solvents, and of iodine, water, and carbonic acid upon the photo-polymerisation of this compound.—*Z. Rusk. Chim. Obsé.*

Action of Zinc-ethyl upon Iso-butylene Bromide.—D. Looff.—The author obtained by this reaction amyl-bromide, boiling at 110° to 115°. He hopes, proceeding from this compound, to arrive at a new primary amylic alcohol.—*Z. Rusk. Chim. Obsé.*

Action of Nitric Acid upon Iso-tributylene.—D. Konovaloff.—On treating iso-tributylene with nitric acid the author obtains a compound which yields an amine on reduction.—*Z. Rusk. Chim. Obsé.*

A New Crystalline Hydrocarbon.—M. Chrapovicky.—The author obtainsd the body in question by the action of sodium upon the ethereal solution of tertiary butyl-iodide.—*Z. Rusk. Chim. Obsé.*

Tetrolic Acid.—G. Lagermark.—An account of the preparation of tetrolic chlor-anhydride.—*Z. Rusk. Chim. Obsé.*

On Oil of Lemon.—F. Flawitzky.—Commercial oil of lemon contains, in addition to the dextro-rotatory, a lævo-rotatory terpene, to the extent of not less than 10 per cent. The latter entirely agrees in its properties with the terpene of French oil of turpentine.—*Z. Rusk. Chim. Obsé.*

MEETINGS FOR THE WEEK.

MONDAY, 23dr.—Royal Geographical (Anniversary), 2.30.
TUESDAY, 24th.—Civil Engineers, 8.
— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.
— Medical and Chirurgical, 8.30.
WEDNESDAY, 25th.—Society of Arts, 8.
— Geological, 8.
THURSDAY, 26th.—Royal Institution, 3. "Magnetism," Professor Tyndall.
— Quekett, 8.
FRIDAY, 27th.—Royal Institution, 8. "Artificial Production of Indigo," Prof. H. E. Roscoe, 9.
SATURDAY, 28th.—Royal Institution, 3. "Russian Literature: Lermontoff," Prof. C. E. Turner.
— Physical, 3.

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ON DISCONTINUOUS PHOSPHORESCENT SPECTRA IN HIGH VACUA.*

By WILLIAM CROOKES, F.R.S.

In a paper which I had the honour of presenting to the Royal Society in March, 1879,† I drew attention to the fact that many substances, when in high vacua and submitted to the molecular discharge by means of an induction coil, emitted phosphorescent light; and I especially mentioned the phosphorescent sulphides, the diamond, the ruby, and various other forms of alumina, crystalline and amorphous.

Pure alumina chemically prepared has very strong phosphorescence. Sulphate of alumina is dissolved in water, and to it is added an excess of solution of ammonia. The precipitated hydrate of alumina is filtered, washed, ignited, and tested in the molecular stream. It phosphoresces of the same crimson colour, and gives the same spectrum as the ruby.

Alumina in the form of ruby glows with a full rich red colour, and when examined in the spectroscope the emitted light is seen to be discontinuous. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line, to which nearly the whole of the intensity of the coloured glow is due. The wave-length of this red line, which appears characteristic of this form of alumina, is, as near as I can measure, λ 689·5 m.m.m. This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina in its various forms, when glowing in the phosphoroscope.

This coincidence is of considerable interest, as it shows a relation between the action of molecular impact and of sunlight in producing luminosity. The phosphorescence induced in a crystal of ruby by the molecular discharge is not superficial, but the light comes from the interior of the crystal, and is profoundly modified according as its direction of vibration corresponds or makes an angle with the axis of the crystal, being quenched in certain directions by a Nicol prism.

Sunlight falling on the ruby crystal produces the same optical phenomena. The light is internally emitted, and on analysis by a prism is seen to consist essentially of the one brilliant crimson line, λ 689·5. This fact may account for the extraordinary brilliancy of the ruby, which makes it so highly prized as a gem. The sun not merely renders the red-coloured stone visible, as it would a piece of coral, but it excites the crystal to phosphorescence, and causes it to glow with a luminous internal light, the energy of which is not diffused over a broad portion of the spectrum, but is chiefly concentrated into one wave-length.

The crimson glow of alumina remains visible some time after the current ceases to pass. When the residual glow has ceased it can be revived by heating slightly with a spirit-lamp.

After long experimenting with chemically pure alumina precipitated from the sulphate as above described, a curious phenomenon takes place. When sealed up in the vacuum two years ago it was snow white; but after being frequently submitted to the molecular discharge for the purpose of exhibiting its brilliant phosphorescence, it gradually assumes a pink tinge, and on examination in sunlight a trace of the alumina line can be detected. The repeated molecular excitation is slowly causing the amorphous powder to assume a crystalline form.

* A Paper read before the Royal Society, May 19, 1881.
† *Phil. Trans.*, Part 2, 1879. p 660.

Under some circumstances, alumina glows with a green colour. Ammonia in large excess was added to a dilute solution of alum. The strong ammoniacal solution filtered from the precipitated alumina was now boiled. The alumina which the excess of ammonia had dissolved was thereby precipitated. This was filtered off, ignited, and tested in the molecular discharge. It gave no red light whatever, but phosphoresced of a pale green, and on examination with a prism the light showed no lines, but only a concentration of light in the green.

Two earthen crucibles were tightly packed, the one with sulphate of alumina, the other with acetate of alumina. They were then exposed, side by side, to the most intense heat of a wind furnace—a heat little short of the melting-point of platinum.* The resulting aluminas were then tested in the molecular stream.

The alumina from the sulphate gave the crimson glow and spectrum line.

The alumina from the acetate gave no red glow or line, but a pale green phosphorescence.

In my examination of rubies, many pounds of which have passed through my apparatus, I have been fortunate enough to meet with one solitary crystal, not to the eye different from others, which emits a *green* light when tested in the molecular stream. All others act as I may call normally. The spectrum of this green-glowing crystal shows, however, a trace of the red line, and on keeping the discharge acting on it for a few minutes the green phosphorescence grows fainter and a red tinge is developed, the spectrum line in the red becoming more distinct.

Besides the Ruby, other native forms of crystallised alumina phosphoresce. Thus corundum glows with a pink colour. The sapphire appears to be made up of the red-glow and the green-glow alumina. Some fine crystals of sapphire shine with alternate bands of red and green, arranged in layers perpendicular to the axis. Unfortunately it is impossible to prepare a tube for exhibition containing this variety of sapphire, as it is constantly evolving gas from the numerous fissures and cavities which abound in this mineral.

The red glow of alumina is chiefly characteristic of this earth in a free state. Few of its compounds, except Spinel (aluminate of magnesium), either natural or artificial, show it in any marked degree. All the artificially crystallised aluminas give a strong red glow and spectrum line. An artificially crystallised aluminum and barium fluoride phosphoresces with a blue colour, but shows the red alumina line in the spectrum. Spinel glows red, and gives the red line almost as strong as the ruby.

The mineral Spodumene (an aluminium and lithium silicate) phosphoresces very brilliantly with a rich golden yellow colour, but shows no spectrum line, only a strong concentration of light in the orange and yellow. A phosphorescing crystal of Spodumene has all the internal light cut off with a Nicol prism, when the long axes of the Nicol and the crystal are parallel.

It became of interest to see if the other earths would show phosphorescent properties similar to those of alumina, and especially if any of them would give a discontinuous spectrum; considerable interest attaching to a solid body whose molecules vibrate in a few directions only, giving rise to spectrum lines or bands on a dark background.

Glucina prepared with great care is found to phosphoresce with a bright blue colour, but no lines can be detected in the spectrum, only a concentration of light in the blue.

The rare mineral phenakite (aluminate of glucinum), sometimes used as a gem, phosphoresces blue like pure glucina, no trace of the alumina line being found in its spectrum. This mineral shows a residual glow after the current is turned off.

Thorina has very little, if any, phosphorescence. This earth is, however, remarkable for its very strong attraction for the residual gas in the vacuum tube. On putting

* This operation was kindly performed for me by Messrs. Johnson and Matthey.

thorina in a tube furnished with well-insulated poles whose ends are about a millimetre apart in the centre, and heating strongly during exhaustion, the earth on cooling absorbs the residual gas with such avidity that the tube becomes non-conducting, the spark preferring to pass several inches in air rather than strike across the space of a millimetre separating the two poles. It is probable that this strong attraction for gas is connected with the great density of the earth thorina (sp. gr. = 9·4).

Zirconia gives a very brilliant phosphorescence, approaching in intensity that of sulphide of calcium. The colour is pale bluish green, becoming whiter as the intensity of the discharge increases: no lines are seen in its spectrum.

Lanthana precipitated as hydrate and ignited shows no phosphorescence. After it has been heated for some time before the blowpipe it phosphoresces of a rich brown.

Didymia, from the ignition of the hydrate, has scarcely any phosphorescence; what little there is appears to give a continuous spectrum with a broad black band in the yellow-green. On examining the light reflected from this earth when illuminated by day or artificial light, the same black band is seen, and with a narrow slit and sunlight the band is resolved into a series of fine lines, occupying the position of the broadest group of absorption lines in the transmission spectrum of didymium salts.

Yttria shows a dull greenish light, giving a continuous spectrum.

Erbia phosphoresces with a yellowish colour, and gives a continuous spectrum, with the two sharp black bands so characteristic of this earth cutting through the green at λ 520 and 523. These lines are easily seen in the light reflected from erbia when illuminated by daylight. It is well known that solid erbia heated in a flame glows with a green light, and gives a spectrum which chiefly consists of two bright green lines in the same place as the dark lines seen by reflected light.

A curious phenomenon is presented by erbia when the spark passes over it at a high exhaustion. The particles of earth which have accidentally covered the poles are shot off with great velocity, forming brightly luminous lines, and, striking on the sides of the tube, rebound, remaining red-hot for an appreciable time after they have lost their velocity. They form a very good visible illustration of Radiant Matter.

Titanic acid phosphoresces dark brown, with gold spots in places.

Stannic acid gives no phosphorescence.

Chromic, ferric, and ceric oxides do not appreciably phosphoresce.

Magnesia phosphoresces with a pink opalescent colour, and shows no spectrum lines.

Baryta (anhydrous) scarcely phosphoresces at all. Hydrated baryta, on the contrary, shines with a bright orange-yellow light, but shows no discontinuity of spectrum; only a concentration in the yellow-orange.

Strontia (hydrated) phosphoresces with a beautiful deep blue colour, and when examined in the spectroscope the emitted light shows a greatly increased intensity at the blue and violet end, without any lines or bands.

Lime phosphoresces of a bright orange-yellow colour, changing to opal-blue in patches where the molecular discharge raises the temperature. In the focus of a concave pole the lime becomes red- and white-hot, giving out much light. This earth commences to phosphoresce more than 5 millims. below the vacuum, and continnes to grow brighter as long as the electricity is able to pass through the tube. On stopping the discharge there is a decided residual glow. No lines are seen in the spectrum of the light.

Calcium carbonate (calcite) shows a strong phosphorescence, which begins to appear at a comparatively low exhaustion (5 m.m.). The interior of the crystal shines of a bright straw colour, and the ordinary and extraordinary rays are luminous with oppositely polarised light. Calcite shows the residual glow longer than any substance I have as yet experimented with. After the current has been turned off the crystals shine in the dark with a yellow light for more than a minute.

Calcium phosphate generally gives an orange-yellow phosphorescence and a continuous spectrum. Sometimes, however, a yellow-green band is seen superposed on the spectrum.

Potash phosphoresces faintly of a blue colour. The spectrum shows a concentration at the blue end, but the light is too faint to enable lines, if any, to be detected.

Soda phosphoresces faintly yellow, and give the yellow line in the spectrum.

Lithium carbonate gives a faint red phosphorescence. Examined in the spectroscope, the red, orange, and blue lithium lines are seen.

I have already said that the diamond phosphoresces with great brilliancy. In this respect perfectly clear and colourless stones "of the first water" are not the most striking, and they generally glow of a blue colour. Diamonds which in sunlight have a slight fluorescence disappearing when yellow glass is interposed, generally phosphoresce stronger than others, and the emitted light is of a pale yellowish green colour.

Most diamonds which emit a very strong yellowish light in the molecular discharge give a continuous spectrum, having bright lines across it in the green and blue. A faint green line is seen at about λ 537; at λ 513 a bright greenish blue line is seen, and a bright blue line at λ 503. A darkish space separating the last two lines.

Diamonds which phosphoresce red generally show the yellow sodium line superposed on a continuous spectrum.

There is great difference in the degree of exhaustion at which various substances begin to phosphoresce. Some refuse to glow until the exhaustion is so great that the vacuum is nearly non-conducting, whilst others commence to become luminous when the gauge is 5 or 10 millimetres below the barometric level. The majority of bodies, however, do not phosphoresce till they are well within the negative dark space.

During the analysis of some minerals containing the rarer earths experimented on, certain anomalies have been met with, which seem to indicate the possible presence of other unknown elements awaiting detection. On several occasions an earthy precipitate has come down where, chemically speaking, no such body was expected; or, by fractional precipitation and solution, from a supposed simple earth something has separated which in its chemical characters was not quite identical with the larger portion; or, the chemical characteristics of an earth have agreed fairly well with those assigned to it in books, but it deviated in some physical peculiarity. It has been my practice to submit all these anomalous bodies to molecular bombardment, and I have had the satisfaction of discovering a class of earthy bodies which, whilst they phosphoresce strongly, also give spectra of remarkable beauty.

The spectrum seen most frequently is given by a pale yellowish coloured earth. It consists of a red, orange, citron, and green band, nearly equidistant, the citron being broader than the others and very bright. Then comes a faint blue, and lastly two very strong blue-violet bands. These bands, when seen at their best, are on a perfectly black background; but the parent earth gives a continuous spectrum, and it is only occasionally, and as it were by accident, that I have so entirely separated it from the anomalous earth as to see the bands in their full purity. Another earthy body gives a spectrum similar to that just described, but wanting the red, and having a double orange and double citron band. A third gives a similar spectrum, but with a yellow line interposed between the double orange and the double citron, and having two narrow green lines.

At present I do not wish to say more than that I have strong indications that one, or perhaps several new elements are here giving signs of their existence. The quantities I have to work upon are very small, and when each step in the chemical operation has to be checked by an appea

to the vacuum tube and to the induction coil the progress is tediously slow. In the thallium research it only occupied a few minutes to take a portion of a precipitate on a platinum loop, introduce it into a spirit-flame, and look in the spectroscope for the green line. In that way the chemical behaviour of the new element with reagents could be ascertained with rapidity, and a scheme could be promptly devised for its separation from accompanying impurities. Here, however, the case is different: to perform a spectrum test, the body under examination must be put in a tube and exhausted to a very high point before the spectroscope can be brought to bear on it. Instead of two minutes, half a day is occupied in each operation, and the tentative gropings in the dark, unavoidable in such researches, must be extended over a long period of time.

The chemist must also be on his guard against certain pitfalls which catch the unwary. I allude to the profound modification which the presence of fluorine, phosphorus, boron, &c., causes in the chemical reactions of many elements, and to the interfering action of a large quantity of one body on the chemical properties of another which may be present in small quantities.

The fact of giving a discontinuous phosphorescent spectrum is in itself quite insufficient to establish the existence of a new body. At present it can only be employed as a useful test to supplement chemical research. When, however, I find that the same spectrum-forming earthy body can always be obtained by submitting the mineral to a certain chemical treatment; when the chemical actions which have separated this anomalous earth are such that only a limited number of elements can possibly be present; when I find it impossible to produce a substance giving a similar discontinuous spectrum by mixing together any or all of the bodies which alone could survive the aforesaid chemical treatment;—when all these facts are taken into consideration, and when due weight is given to the very characteristic spectrum reaction, I cannot help concluding that the most probable explanation is that these anomalies are caused by the presence of an unknown body whose chemical reactions are not sufficiently marked to have enabled chemists to differentiate it from associated elements.

STEEL FOR THE MANUFACTURE OF DIES.*

By Prof. W. CHANDLER ROBERTS, F.R.S.

[The following article was originally written as a departmental report only. The suitability of steel for the manufacture of dies has been so little examined, and the peculiar conditions die-steel has to meet are so little understood, that we gladly avail ourselves of Professor Roberts's permission to reprint the article.—*Ed.* C.N.]

I have referred in former Reports† to the question of steel for the manufacture of dies, and attention has frequently been drawn to the difficulty experienced in obtaining metal of suitable quality. Our knowledge of the relation between the chemical composition and the mechanical properties of steel may almost be said to have been created since 1849, when the late Professor Brande stated, in evidence before the Royal Commission on the Mint, that he had analysed numerous varieties of steel, but ascribed its peculiarities more to mechanical texture than to chemical composition.‡ Not long since the appearance of the fracture of a sample of metal was considered to afford trustworthy and sufficient evidence as to its nature and properties; but such rough methods have now given place to the rigorous physical, chemical, and mechanical investigations to which metals must be submitted as a matter of ordinary routine.

Although the steel at present supplied to the Mint appears to show a marked improvement in the number of coins struck per pair of dies, the difficulty involved in the production of a suitable quality of steel demands careful attention, and it appears probable that an examination of the many advances in the metallurgy of steel that have been made in recent years cannot fail both to indicate the chemical and physical conditions which a die-steel should satisfy, and to show the direction in which advance in its manufacture should be sought.

In regard to the first of these points it must be admitted that the information to be gathered is but limited; for, notwithstanding the elaborate system of tests above referred to, eminent authorities on the subject hold that the recognised tests should be supplemented by experiments in which the metal is actually employed for the purpose for which it is required.

It will be well first to briefly examine the chemical conditions which influence the resistance of metal to mechanical strain. Carbon, it is well known, gives to iron fusibility and renders it capable of being cast in moulds. The result of very many experiments appears to show that the presence of 0·15 per cent of carbon converts wrought-iron into steel, rendering it capable of being slightly hardened; beyond 1·5 per cent of carbon the metal ceases to be malleable, and is known as cast-iron. The influence of this metalloid on the tensile strength is, moreover, very remarkable. Thus, an increase from 0·15 to 0·18 per cent of carbon will suffice to increase the breaking strain by several tons per square inch. Manganese is generally considered to act in a similar manner to carbon,* but in certain cases it is found to be specially beneficial in that it makes the metal forge more readily.

Silicon appears to render steel fragile under impact and diminishes its resistance to traction. A small quantity of this element is, however, serviceable in rendering the material known as "ingot-metal" free from blow-holes. With regard to sulphur and phosphorus it is admitted that the presence of these metalloids is on the whole prejudicial, but their influence need not be specially dwelt upon here, as they do not occur in sensible quantities in the high qualities of steel which can alone be used for the manufacture of dies.

The effect of the simultaneous presence of two or more of the above-mentioned elements in steel is extremely complex, and often uncertain, so that it must be long before we can hope for a complete solution of the question. It therefore becomes necessary to consider specific cases.

The following analyses of typical samples of steel employed in the Mint for dies were made by Mr. W. F. Ward, my Assistant in the Metallurgical Laboratory of the Royal School of Mines:—

	A.	B.	C.	D.
Iron	98·93	98·63	98·64	by diff. 98·07
Carbon	0·82	1·07	0·79	1·19
Manganese ..	0·10	0·12	0·24	0·45
Silicon	0·05	0·06	0·18	0·29
Sulphur	trace	trace	0·01	trace
Phosphorus ..	—	trace	0·01	trace
Copper	—	—	0·02	—
	99·90	99·88	99 89	100·00

The sample marked A was a die of exceptional quality having struck no less than 200,000 florins, the normal out-turn of a florin die not exceeding 50,000 pieces. B is the steel now employed, which, during the past year, has been found to yield an average out-turn of 54,000 pieces per pair of dies. C proved in practice to be of unsatisfactory quality, owing to the frequency with which it cracks during the operation of hardening, and this fault was still

* Reprinted from the "Eleventh Annual Report of the Deputy Master of the Mint."

† Report on European Mints; Parliamentary Paper 466 (1870), p. 27; Eighth Annual Report (1877), p. 40; Ninth Annual Report (1878), p. 39.

‡ Minutes of Evidence, Royal Mint Commission, 1849, p. 181.

* "Les Métaux a l'Exposition Universelle de 1878." Par H Lebasteur, Paris, 1878, p. 74.

more marked in the sample D. Their use has therefore been discontinued.

It is unquestionable that the variations in the amounts of the constituent elements indicated by the above analyses to some extent explain the relative merits of the samples. As has already been stated, the property of hardening is mainly due to the presence of carbon; indeed Chernoff, Siemens, and many others are of opinion that true steel is a mixture or combination of carbon and pure iron alone, and that all other substances are impurities necessarily injurious in pure steel, though sometimes apparently beneficial if they exclude or neutralise more injurious substances.* Deshayes† has shown that the broad groupings into which steels may be divided (on the basis of their tensile strength) are characterised by marked, although gradual, differences in the amount of carbon they contain. This metalloid is the one on which the mechanical properties centre, and the elaborate researches of the distinguished engineer whom I have just mentioned seem to point to the fact that a steel containing from 0·6 to 0·75 per cent of carbon will be found best suited for the manufacture of dies, providing the amount of other metalloids present is satisfactory. Bearing in mind the fact already alluded to, that a difference of only 0·03 per cent in the carbon is known to materially alter the tensile strength, it seems reasonable to conclude that the inferiority of sample B as compared with A may be mainly attributed to the amount of carbon it contains. In regard to sample C, the amount of manganese and silicon is relatively high, and it may be confidently asserted that there is sufficient chemical reason for its marked failure as a material for dies. It would appear probable that the physical conditions to which it has been subjected in hardening and tempering were unsuitable, and have also contributed to such a result. With reference to D, the manganese and silicon are exceptionally high, and it is obviously, therefore, far removed from the class of steel that past experience has shown to be suitable.

The question will be seen to be one of extreme complexity, and even when the examination of the metal is limited to its actual employment for the purpose for which it is required, there still remain a great number of conditions, the influence of each of which has to be investigated. Taking the metal as received in square bars from the manufacturers, the operations to which it is subjected in conversion into dies are—forging, turning, striking, hardening, tempering; and the influence of variations in such of these processes as can be varied should be examined while all others remain constant. Thus in his Memorandum for last year,‡ Mr. Hill adduced some figures tending to show that dies forged by the steam-hammer afford better results than those forged by hand; and in his Memorandum for 1876§ a table is given, from which it appears that the form of press used also exercises a material influence. It is, however, well to remember, in considering such a question, that the quality of different bars, even from the same parcel, varies both in regard to their chemical and physical properties; indeed it is now recognised that the same bar may be expected to vary throughout its length. This would alone account for the well-known fact that dies made of the same metal differ widely in the number of coins they produce before cracking, and it points to the necessity of only drawing conclusions from as large a number of experiments as possible.

It would appear that the extensive experience of the Mint in the use of steel for dies might be expected to afford valuable information as to the conditions to be satisfied by the metal in order that it may be specially adapted for such a purpose; but the many slight variations of condition, the difference in the denomination of coin struck (and therefore in the pressure applied), and in the character of coining-press used, render it impossible to draw other than general conclusions from the ordinary work of the Department.

Turning to the general investigations which have been made into the resistance of metals, it is to be observed that very little information is available which can be regarded as strictly bearing on the question of dies. The direct tests for resistance to impact—as, for example, those applied to armour-plates—cannot be considered to afford a guide in the selection of steel for such a purpose; and even if they could be accepted in relation to impacts like those of a coining-press, the operation of hardening is of so delicate a nature, and its influence on the physical properties of the metal is so little understood that any conclusions would probably require considerable modification in practice.

Nevertheless, it may be well to note the basis on which these tests are made. Kirkaldy* concludes, as the result of experiments, that the contraction per cent where rupture occurs in the usual form of test-piece affords very trustworthy information as to the value of steel. Prof. Åkerman,† of Stockholm, takes the fraction formed by dividing the limit of elasticity (usually expressed in tons per square inch) by the breaking strain, expressed in the same terms, as a coefficient, and Deshayes‡ prefers to adopt the difference between these two numbers as a measure of the power of a given sample of steel to resist impact.

It is, however, important to notice that the coefficient here referred to indicates the extreme force which the metal will support, and thus cannot be applied to the case of a die, which is subjected to a prolonged series of impacts, the force of which is considerably under that at which crushing would occur. A somewhat analogous case—that of steel in a constant state of vibration, as the springs of railway carriages—has been investigated by Wöhler,§ and he concludes that the difference in the tension of the metal at the extreme limits of each vibration may be taken as a measure of its resistance. He further states that the amount of the tension may be increased in proportion as this difference becomes less.

It is to be observed that Åkerman's criterion for resistance to impact is also a criterion for ductility, for the smaller the ratio $\frac{L}{R}$ (L being the limit of elasticity and R the breaking load) becomes, the greater is the force beyond the limit of elasticity that the substance can resist without fracture, and the tougher accordingly it is. But in hardened steel the limit of elasticity is increased so as to approximate to the breaking load, and the ductility together with the resistance to shock will thus diminish, as is indicated by the increase in the value of the fraction $\frac{L}{R}$. This fraction appears to afford one datum for determining the properties that characterise a good die-steel, but Åkerman himself points out that it has not yet been sufficiently studied even by engineers, and it is impossible for me to say how far it bears on the question under consideration.

In addition to resisting shock, a die-steel is required to satisfy yet another important condition. It must retain the precise form given to it, so that the engraved device is not distorted by the impact; or, in other words, the steel must have a high limit of elasticity. As is well known, and as is indicated in the subjoined table, such a condition is best satisfied by hardening the metal, but, when this is done, the rules above given for determining

* Institution of Mechanical Engineers. First Report of the Committee on the Hardening, Tempering, and Annealing of Steel, 1879.

† "Classement et Emploi des Aciers." Par V. Deshayes, Paris, 1879.

‡ "Tenth Annual Report" (1879), p. 36.

§ "Seventh Annual Report" (1876), p. 34.

* "Experiments on Wrought Iron and Steel." By David Kirkaldy, page 91.

† *Journal of the Iron and Steel Institute* (1879), No. 2, p. 504.

‡ "Classement et Emploi des Aciers," p. 96.

§ Uber die Festigkeitsversuche mit Eisen und Stahl. Berlin, 1870.

Tensile Tests.

No. of Expt.	Sample of Steel.	Dimensions. Diameter.	Dimensions. Length.	Limit of Elasticity. Pounds per sq. in.	Limit of Elasticity. Tons per sq. in.	Breaking Load. Pounds per sq. in.	Breaking Load. Tons per sq. in.	Ratio of Limit to Breaking Load.	Ultimate Permanent Extension in 10 inches.	Modulus Elasticity. (E.)
		Inch.	Inches.						Per cent.	Pounds per sq. in.
1	B soft	0·694	10	69,200	30·88	126,600	56·50	0·547	4·78	31,350,000
2	B hard	0·700	10	—	—	97,400	43·49	—	About 0·02	30,400,000
3	C soft	0·694	10	55·550	24·80	114,150	50·96	0·487	7·59	29,760,000
4	C hard	0·698	10	138,300	61·76	139,600	62·32	0·991	Just perceptible.	30,860,000
5	D soft	0·694	10	74,200	33·13	141,270	63·06	0·525	3·63	30,960,000
6	D hard	0·701	10	About 92,000	About 41·07	133,700	59·63	0·688	Not visible	30,310,000

Compressive Tests.

No. of Expt.	Sample of Steel.	Dimensions. Diameter.	Dimensions. Length.	Maximum total Load Applied.	Maximum Load per square inch. Pounds.	Maximum Load per square inch. Tons.	Permanent Compression.
		Inch.	Inch.	Pounds.			Inch.
7	B hard	0·698	0·701	100,000	261,100	116·57	0·020
8	C hard	0·700	0·700	100,000	259,700	115·96	0·002
9	D hard	0·702	0·703	100,000	258,400	115·36	0·002

resistance to impact in all probability become less applicable.

With a view to ascertain the mechanical properties which characterise a good die-steel, samples have been submitted to Professor Kennedy, Memb. Inst. C E., of University College, London, for trial in the special machines employed for testing metals. These samples are indicated by the letters B, C, and D, and are identical with those marked by the same letters in the preceding table of analyses. The results are given in the accompanying tables.

All the specimens of metal, except those used for experiments 1, 3, and 5, were hardened in the same manner and to the same degree as a die, in order that the results obtained might as far as possible be applicable to the metal as used in the Mint. On comparing them, it will be seen that the three qualities are marked by well-defined characteristics, which are in certain cases very unusual. Thus, the breaking load commonly increases on hardening, as in the case of C, but B, and to a less extent D, show a distinct fall, and this result, it should be observed, has been confirmed by duplicate experiments, and is in accordance with the results of certain experiments by Kirkaldy. The high value of Åkerman's criterion, the ratio of the Limit of Elasticity to Breaking Load, in experiment 4, would imply that this steel, although well able to resist impact when soft, is exceptionally bad when hard. The information afforded by the experiments on compression is for the most part of a negative character, as the application of the full load of the machine did not produce any marked impression.

Viewing these mechanical tests in the light of the chemical composition, it is to be observed that C contains 0·28 per cent less carbon, 0·12 per cent more silicon, and 0·12 per cent more manganese than B, and this difference in composition corresponds to a diminution, in the case of the soft specimen of C, of no less than 6 tons per square inch in the breaking load. It may, however, be safely asserted that both the chemical composition of sample C and its mechanical properties prove it to be a good variety of steel, although it appears to be more severely tried than B by the operation of hardening as practised in the Mint. In the case of sample D, the evidence of unsuitability afforded by the chemical and mechanical tests is more apparent, and it has been found to be quite incapable of standing the ordinary method of hardening.

It is as yet impossible to say which of the three varieties of steel (B, C, and D) under consideration would, with treatment that is in every way suitable to it, produce the most perfect die. Unfortunately the sample A, that struck 200,000 florins, being a finished die, could not be tested mechanically; the chemical analysis, however, indicates that it would stand cold water hardening even better than B. There can be no doubt that plunging red-hot steel into cold water severely strains the metal, and the investigation generally (so far as it has been carried) shows the special importance of studying the influence of hardening in the manufacture of dies. I have already made some experiments in this direction, and the results will be communicated to a Committee, of which I am a member, appointed by the Institute of Mechanical Engineers to inquire into the phenomena of Hardening, Tempering, and Annealing of steel.

ON THE

ACTION OF POTASSIUM NITRITE ON AMMONIUM CHLORIDE.

By Dr. D. TOMMASI.

It has long been known that when a solution of potassium nitrite and ammonium chloride is heated, water and nitrogen are formed. But if a mixture of dry potassium nitrite and dry ammonium chloride is heated, such is not the case. The products of this reaction are very complex, and their nature depends on the quantity of the salt used, and particularly on the temperature to which the mixture is heated.

At present I cannot enter into any details on this subject. I only wish to describe in this note a very curious experiment that I have had occasion to make during this research.

If 10 grms. of potassium nitrite are melted in a porcelain crucible, and then a small quantity of ammonium chloride

be added, we notice that this salt commences to rotate with a variable velocity, and then takes fire and burns with a violet-purple flame, accompanied by a feeble detonation, in fact it behaves exactly like a globule of potassium burning on water. With ammonium sulphate the phenomenon is more striking, but only very small quantities should be used, or the experiment will become dangerous on account of the projections. The products of the reaction between potassium nitrite and ammonium chloride are: Potassium chloride, ammonia, nitrous fumes, and probably nitrogen as well. Ammonium sulphate and potassium nitrite give the same products, except, of course, potassium sulphate instead of potassium chloride. Ammonium nitrate, when in contact with melted potassium nitrite, produces a remarkable luminous phenomenon. If the ammonium nitrate is in small crystals, a series of phosphorescent points are formed, but if, on the contrary, one crystal, however small, be introduced, it forms a globule surrounded by a phosphorescent ring, and it rotates with great rapidity, and then suddenly explodes, producing a beautiful flame.

At present I am occupied in examining the nature of the gases which are evolved by the actions of ammonium chloride, sulphate, and nitrate, on potassium nitrite, and when these analyses are finished I shall endeavour to give an explanation of the reactions of which I have spoken.

RELATIONS BETWEEN THE ATOMIC WEIGHTS OF THE ELEMENTS.

By M. MAXIMILIEN GERBER.

We know the celebrated hypothesis of Prout, according to which the atomic weights of the elements are exact multiples of the weight of the atom of hydrogen = 1. The determinations of atomic weights executed by Berzelius, Dumas, and especially Marignac and Stas, have shown that this hypothesis must be abandoned, or at least that it cannot be maintained in its original form.

Thanks to the experimental precision and to the rigour of the methods employed by these chemists, we know now, within a few hundredths, the exact value of about 30 atomic weights. On considering these values we see that they have no common divisor; such a divisor, if existing, could be merely a very small fraction of unity, and for the present would entirely escape experimental verification.

The case is different when, in place of considering the totality of the atomic weights, we compare together the weights of such bodies as form a natural group. Several authors, Dumas being the first, have pointed out more or less close relations between the atomic weights of the elements of one and the same family; for instance, between O, S, Se, Te, — Mg, Ca, Sr, Ba, &c.

I have endeavoured to generalise this fact. On dividing the simple bodies now known into four great classes, characterised by the predominant atomicity of the elements which they include, I find for each of these classes a common divisor, greater than unity, or approaching it very closely. Thus, the atomic weights of the bodies of one and the same class are found to be exact multiples of this common divisor by simple and entire factors.

The first of these classes contains the so-called monoatomic elements, *i.e.*, the alkaline metals which combine with oxygen according to the type R_2O, and with chlorine, RCl; as also the non-metallic halogens, fluorine, chlorine, bromine, iodine.

The second class comprises the elements which are distinctly di- or tetratomic, *i.e.*, on the one hand, the alkaline-earthy metals (RO), and on the other, the non-metallic elements of the family of oxygen and carbon.

In the third class I arrange the elements which act most generally as tri- or penta-valent; nitrogen, boron, &c. The type of their most stable oxide is R_2O_3, and their chlorides are RCl_3 or RCl_5.

The fourth class, lastly, which is by far the most common, comprises the metals properly so-called which present the types of oxygenation RO and R_2O_3.

The following tables will show this fact clearly:—

Mono-atomic Elements, Electro-Positive or Electro-Negative.

Common factor: D = 0·769.

		Atomic Weights.	
Lithium ..	3×3D = 9D = 6·921	Li =	7·01
Sodium ..	10×3D = 30D = 23·07	Na =	23·04
Potassium ..	17×3D = 51D = 39·219	K =	39·1
Rubidium ..	37×3D = 111D = 85·359	Rb =	85·2
Cæsium ..	= 172D = 132·268	Cs =	132·2
Fluorine	25D = 19·225	Fl =	19·1
Chlorine	46D = 35·354	Cl =	35·37
Bromine	104D = 79·976	Br =	79·9
Iodine	165D = 126·885	I =	126·7

Appendix.

Hydrogen	13/10D = 0·9997	H =	1
Silver	140D = 107·66	Ag =	107·66

D = 1·995.

Oxygen ..	1×8D = 8D = 15·96	O =	15·96
Sulphur ..	2×8D = 16D = 31·92	S =	31·98
Selenium ..	5×8D = 40D = 79·80	Se =	79 to 79·46 ?
Tellurium ..	8×8D = 64D = 127·68	Te =	127·8
Magnesium	3×4D = 12D = 23·94	Mg =	23·94
Calcium ..	5×4D = 20D = 39·90	Ca =	39·9
Strontium ..	11×4D = 44D = 87·78	Sr =	87·2 ?
Barium ..	69D = 137·665	Br =	137·0
Carbon ..	6D = 11·97	C =	11·97
Silicon ..	14D = 27·93	Si =	28
Titanium ..	25D = 49·875	Ti =	50 ?
Zirconium ..	45D = 89·775	Zr =	90 ?
Tin	59D = 117·705	Sn =	117·8

Appendix.

Mercury ..	100D = 199·5	Hg =	199·8
Molybdenum	48D = 95·76	Mo =	95·8
Tungsten ..	92D = 183·54	W =	184
Uranium ..	60D = 119·7	U =	120

Third Class.

D = 1·559.

Nitrogen ..	9D = 14·031	N =	14·01
Phosphorus	20D = 31·18	P =	31 ?
Arsenic ..	48D = 74·83	As =	74·9
Antimony ..	71D = 120·04	Sb =	120
Bismuth ..	135D = 210·405	Bi =	210 ?

Appendix.

Gold	126D = 196·434	Au =	196·3

Fourth Class.

D = 1·245.

Glucinum ..	11D = 13·695	G =	13·65
Aluminium	22D = 27·390	Al =	27·4
Scandium ..	36D = 43·575	Sc =	44 ?
Chromium ..	42D = 52·290	Cr =	52·3 to 52·4
Iron	45D = 56·025	Fe =	55·9
Gallium ..	56D = 69·720	Ga =	69·8
Indium ..	91D = 113·295	In =	113·4
Zinc	52D = 64·740	Zn =	64·9
Cadmium ..	90D = 112·050	Cd =	111·6 ?
Manganese	44D = 54·780	Mn =	54·8
Nickel ..	47D = 58·515	Ni =	58 to 59 ?
Cobalt ..	48D = 59·760	Co =	59 to 60 ?

		Atomic Weights.
Copper ..	51D = 63·495	Cu = 63·5
Lead	166D = 206·670	Pb = 206·4
Thallium ..	164D = 204·18	Tl = 203·6 ?
Ruthenium	83D = 103·335	Ru = 103·5 ?
Rhodium ..	84D = 104·580	R = 104·2 ?
Palladium ..	85D = 105·825	Pd = 106·2 ?
Iridium ..	158D = 196·710	Ir = 196·7 ?
Platinum ..	159D = 197·955	Pt = 196·7 to 199 ?
Osmium ..	160D = 199·2	Os = 198·6 to 199·2 ?
Yttrium ..		Yt = 89·6 to 92·5 ?
Cerium ..	110D = 136·95	Ce = 137 ?
Lanthanum	112D = 139·440	La = 139 ?
Didymium..	118D = 146·910	Di = 147 ?
Erbium ..		Er = 162 to 170·6 ?
Thorium ..	184D = 234·060	Th = 233·9 to 234 ?

What importance should be attached to these numerical relations? We may remark at first that the common factors which I make use of have been determined empirically, and that no simple relation exists among them. They have therefore no value in themselves.

If, on the one hand, it is remarkable to find very simple relations for certain well-characterised groups, *e.g.*, O, S, Se, Te; Li, K, Na, Rb, &c., on the other hand there are groups of elements like Cl, Br, I, which present much more complex relations. There is also a great difficulty as regards the elements which may belong to two different series; like Mn, which may be assimilated to the halogens (on account of $Mn_2O_8K_2$), and Zn, which may approximate to Mg, &c.

It seems to me, nevertheless, that the relations which I point out would deserve attention if more precise determinations of the atomic weights should confirm their generality. We might then see in them a method of checking theoretically the atomic weight of each element. But at present we have not advanced so far, and the interest of this classification is contestable.

I wish, nevertheless, to adduce two facts of a kind to give some weight to my views, and which have determined me to publish them in their imperfect state. These are the facts:—

The atomic weights of the rare elements selenium and tellurium may be regarded as not very accurately known. M. Mendeleeff has especially raised doubts on the accuracy of that assigned to tellurium (128·02 according to Berzelius, and 129 according to Dumas). M. Mendeleeff considers these values too high. In the list of the elements arranged in the order of their increasing atomic weights, tellurium ought to rank before iodine, and consequently should have an atomic weight inferior to I = 126·7. To remove this doubt M. W. L. Will has re-determined this contested atomic weight. His analyses lead to the following values:—Te = 127·80, 127·99, 127·74, or a mean of 127·84, O being = 15·96; whilst, according to my system, we should have Te + 127·68. The difference is quite within the limit of errors of observation, in case of such high atomic weights.

The second fact is as follows:—Since the researches of Awdeeff, glucinum has been classed with the diatomic alkaline earthy metals, forming an oxide GO with G'' = 9·3. The specific heat of the metal as determined by Reynolds seemed to confirm this view, and in the classification of Mendeleeff glucinum = 9·3 finds its place between lithium = 7·02 and boron = 11. The recent researches of MM. Nilson and Pettersson on the compounds of glucinum have somewhat modified the *equivalent* of this element. These authors find it = 4·55. But they have shown that in accordance with chemical analogies and the characters of metallic glucinum, it is requisite to revert to the old formula of the oxide glucina as proposed by Berzelius, G_2O_3. Hence the atomic weight becomes = 13·65. This result was in a manner indicated by my attempt at classification. With the atomic weight 9·3, or even 9·1, it is impossible for me to class glucinum with the alkaline earthy metals. But it ranks naturally along with aluminium with an atomic weight, which agrees with that assigned by the researches of MM. Nilson and Pettersson. *Les Mondes.*

BRITISH ASSOCIATION.

The following arrangements have been made for the fifty-first meeting of the British Association, to be held at York:—The first general meeting will be held on Wednesday, August 31, at 8 p.m. precisely, when A. C. Ramsay, F.R.S., will resign the chair, and Sir John Lubbock, Bart., F.R.S., President-Elect, will assume the presidency, and deliver an address. On Friday evening, September 2, a discourse by Prof. Huxley, Sec. R.S.; on Monday evening, September 5, a discourse by W. Spottiswoode, President of the Royal Society.

The general officers are—General Secretaries: Capt. Douglas Galton, F.R.S.; Philip Lutley Sclater, Ph.D., F.R.S. Acting Secretary: George Griffith, F.C.S., Harrow. General Treasurer: Prof. Williamson, F.R.S. Local Secretaries: Rev. Thomas Adams; Tempest Anderson, M.D., B.Sc., York.

The sections are arranged as follows:—

A. *Mathematical and Physical Science.*—President: Prof. Sir William Thomson, F.R.S.

B. *Chemical Science.*—President: Prof. Williamson, For. Sec. R.S.

C. *Geology.*—President: Andrew Crombie Ramsay, LL.D., F.R.S.

D. *Biology.*—President: Richard Owen, F.R.S. Secretaries: G. W. Bloxam, M.A., F.L.S.; W. L. Distant; W. A. Forbes, F.Z.S.; Prof. M'Nab, M.D.; John Priestley; and Howard Saunders, F.L.S., F.Z.S. *Department of Zoology and Botany.*—Richard Owen, F.R.S., will preside. Secretaries: Prof. M'Nab, M.D. (Recorder), and Howard Saunders, F.L.S., F.Z.S. *Department of Anthropology.*—Prof. W. H. Flower, F.R.S., will preside. Secretaries: G. W. Bloxam, M.A., F.L.S. (Recorder), and W. L. Distant. *Department of Anatomy and Physiology.*—Prof. J. S. Burdon Sanderson, F.R.S., will preside. Secretaries: John Priestley (Recorder), and W. A. Forbes, F.Z.S.

E. *Geography.*—President: Sir J. D. Hooker, K.C.S.I., C.B., F.R.S. Secretaries: H. W. Bates, Assist.-Sec. R.G.S., F.L.S, and E. C. Rye, Librarian R.G.S., F.Z.S. (Recorder).

G. *Mechanical Science.*—President: Sir W. G. Armstrong, C.B., F.R.S.

Tickets for the meeting may be obtained of the Local Secretaries at York, and at the office of the Association, 22, Albemarle Street, London, W.; or on application by letter, from August 17 to August 24, to the General Treasurer, Prof. A. W. Williamson, British Association, University College, London, W.C.

Influence of the Concentration of the Liquids upon the Electro-motive Force of a Daniell's Element.—J. V. Hepperger.—The current proceeds invariably from the more to the less dense solution. The electro-motive force of a 1 per cent solution of zinc-sulphate as compared with one of 10, 20, 30, 40, 50, 60 per cent. and one saturated is as 11, 18, 21, 25, 31, 37, 41. The electro-motive force of a 1 per cent solution of copper sulphate as against those of 5, 10, 15, 20, 25, 30 and a saturated one is as 13, 18, 21, 24, 26, 27, 29.—*Wiener Anzeiger.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 19, 1881.

Prof. H. E. ROSCOE, President, in the Chair.

THE following certificates were read for the first time:—H. Frankland, A. J. Hailes, J. P. Wilkes.

The following papers were read:—"*On Ammonium Nitrite and the Reaction between Hydrogen and Nitric Oxide in the Presence of Spongy Platinum*," by L. T. WRIGHT. The author has been engaged in studying the reaction between ammonium chloride and potassium nitrite when a solution of these substances is boiled. He finds that free ammonia and ammonium nitrite are always present in the distillate, and that the equation is much more complicated than that usually given,—

$$NH_4Cl+KNO_2=N_2+KCl+2H_2O.$$

Further quantitative work on this reaction is promised. The author then repeated the experiments of G. S. Johnson (*Chem. Soc. Journ.*, March, 1881) "On the Synthesis of Ammonia from Nitrogen and Hydrogen in the Presence of Spongy Platinum." He has been quite unable to confirm Mr. Johnson's results. When hydrogen and nitrogen (3 : 1) were passed through spongy platinum, small quantities of ammonia were always formed, but the nitrogen always contained traces of nitric oxide, recognised by the odour of nitrous acid when mixed with air, and the discolouration of iodide of potassium and starch papers. The author found that the ferrous sulphate solution did not absorb the nitric oxide completely, and, as is well known, nitric oxide and hydrogen form ammonia when passed over spongy platinum. When nitrogen from the action of potassium hypobromite and ammonium chloride was used, instead of the nitrogen from ammonium nitrite, no ammonia was formed in the above experiment. Also, by passing the nitrogen evolved by boiling potassium nitrite and ammonium chloride through absorption tubes charged with an alkaline solution of sodium sulphite, instead of ferrous sulphate, the nitric oxide was decomposed, and in one experiment lasting an hour, only 0·003 milligrm. of NH_3 was produced, and in a second none. The author draws the following conclusions:—That nitric oxide is not completely absorbed by ferrous sulphate at ordinary temperatures; that hydrogen reacts upon nitric oxide to form ammonia in the presence of cold spongy platinum when the hydrogen is in sufficient excess; that with nitrous oxide no such reaction takes place; that nitrogen and hydrogen do not synthetically combine to produce ammonia in the presence of spongy platinum, at least, when the nitrogen is produced by the decomposition of ammonium nitrite.

Mr. JOHNSON said that practically the author confirmed his result that when nitrogen purified by passing through ferrous sulphate was passed with hydrogen over spongy platinum, ammonia was formed. He begged to dissent, however, from the author's conclusion that the nitrogen employed by himself contained NO. The gas which he used had been passed for a whole hour over heated finely-divided copper without altering its weight. It was therefore quite free from NO.

Mr. WARINGTON suggested that the question as to whether the gas contained NO or not might be set at rest by adding oxygen to the nitrogen, and passing the mixture into potassium iodide.

A short discussion then ensued, in which Dr. Tidy, Messrs. J. M. Thomson, Johnson, Wright, Thorp, and Warington took part, as to the decomposition of nitric oxide by heated metallic copper; the general opinion seemed to be that under certain circumstances traces of NO might escape decomposition although passed over several inches of heated copper.

Mr. J. M. THOMSON then communicated a paper "*On the Synthetical Production of Urea from Benzol, Ammonia, and Air by the Action of Heated Platinum*," by E. F. HERROUN. The author has aspirated air through benzol and ammonia, and then passed the mixed vapours over heated platinum wire Urea was formed mixed with ammonium carbonate and sulphate and some substance of a resinous nature, soluble in ether. The urea was purified and agreed in its reactions and composition with ordinary urea. Spongy platinum and platinised asbestos and charcoal were substituted for the wire, but no urea was formed; also when olefiant gas was used instead of benzol vapour, no urea was produced. Acetylen, on the other hand, behaved in a similar way to benzol, and a considerable yield of urea was obtained.

"*On a Proposed Volumetric Method for the ready Estimation of a Soluble Sulphite and Free Sulphurous Acid, or of Free Sulphurous and Sulphuric Acids, even in the Presence of Sulphates*," by O. V. PISANI. This proposed method is based on the following two equations:—

(1.) $M''SO_3+I_2+H_2O=M''SO_4+2HI.$

(2.) $SO_2+I_2+2H_2O=H_2SO_4+2HI.$

By (1) it is seen that one molecular weight of a sulphite yields two molecules of hydriodic acid, and by (2) that free sulphur dioxide yields in addition one molecule of free sulphuric acid. The author proposes to estimate the iodine used, and the soda required to neutralise the fluid after the addition of the iodine, and from these data estimate the free and combined sulphurous acid. To estimate the sulphates, all the sulphur is oxidised by chlorine, and the sulphates produced from the sulphites deducted. The author has apparently not tested the practical working of the process, and no experiments are given in the paper which he submits to the criticism of the Society.

"*On the Identification of Crystallised Alkaloids, &c., by the Microscope and the Use of Polarised Light*," by A. PERCY SMITH. The author states that the use of the microscope in chemical analysis is usually ignored in text-books not specially devoted to microscopic research, and that he has found the advantage of an optical examination in determining the purity of a crystalline salt. He has used polarised light with selenite plate in the ordinary way. The paper is accompanied with careful drawings of crystals of strychnin, santonin, brucin sulphate, cantharidin, &c. In most cases this mode of identification only applies to pure alkaloids or their salts, any admixture with other crystallisable bodies proving fatal. The author has, however, recognised cantharidin in a mixture of twenty-five alkaloids, and identified strychnin, cantharidin, santonin, opium, and laburnum in a mixture of lentil soup, bread, meat, and cheese.

Prof. TIDY said that he had some experience in this subject, and that in most cases the microscope was of little use in identifying the alkaloids by their crystalline form, as a trace of some other substance sometimes altered the appearance enormously. Thus a trace of piperin would completely alter the crystalline form of strychnin.

"*On the Colour-properties and Colour-reactions of the Metals of the Iron-copper Group*," by T. BAYLEY. The author continues in this paper his previous investigations as to the quantities of cobalt and nickel, or cobalt, copper, and iron, as sulphates, which when mixed produce colourless grey solutions. Thus at 5° C. a mixture of 1 part of copper, and 1½ parts of iron simulates a solution of nickel sulphate, at 15° C. equal parts of iron and copper are required. The two following mixtures are chromatically neutral:—20 parts copper, 7 iron, 6 cobalt; and 13 copper, 8·75 nickel, 6 cobalt, so that 8·75 parts of nickel are equal as regards quality of colour to 7 parts of iron + 7 parts of copper. These colourless opaque solutions in sufficient thickness transmit no light, and the light transmitted by solutions of less thickness is compound white light made up of the rays of two complementary beams, one having its centre in the yellow and the other in the indigo.

Under certain circumstances described in the paper, nickel forms yellow, copper forms copper-red, and cobalt forms orange solutions.

"*On the Effects of the Growth of Plants on the amount of Matter Removed from the Soil by Rain*," by E. W. Prevost. The experiments were carried on in large glazed stoneware pans, 18" in diameter, 10" deep, each containing 100 lbs. of soil, and provided with arrangements for collecting the drainage water. Analyses of the soil, drainage water, composition of the ash of the plants, &c., are given in elaborate tables. The plants grown included cabbage, wheat, beans, clover, and turnips.

The President, in asking for any remarks on the paper, took the opportunity to express his regret that the authors of communications were not more frequently present, as it was almost impossible to grasp the salient points of a paper on hearing it read for the first time.

"*On the Action of Sodium on Cinnamic Ether*," by F. Hatton. This paper is a continuation of some previous work of Dr. Hodgkinson's. The author has studied the reaction, and concludes that it is probably represented in the case of β-phenyl-acrylate by the equation—

$$6C_6H_5.CH=CH,COOC_2H_5+Na_2=$$
$$=2\begin{Bmatrix}CH_3\\COOEt\end{Bmatrix}+2\begin{Bmatrix}C_6H_5CHCH\\COONa\end{Bmatrix}+2(C_{20}H_{20}O_2)+H_2.$$

The substance $C_{20}H_{20}O_2$ decomposes partially on distillation. The action of ethylic β-phenyl-propionate is similar.

The Society then adjourned to June 2, when the following papers will be read:—"On Isomeric Acids Obtained from the Ethers of the Hydride of Salicyl and from Coumarins," by W. H. Perkin; "On the Saponification of Fatty Oils and Waxes," by A. H. Allen and W. Thomson; "On the Sulphides of Copper and a Determination of their Molecular Weights," by S. Pickering.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, March 4, 1881.

William Bowman, Esq., F.R.S., Vice-President in the Chair.

"*Elasticity Viewed as Possibly a Mode of Motion.*" By Sir William Thomson, LL.D., F.R.S., &c.

With reference to the title of his discourse the speaker said: "The mere title of Dr. Tyndall's beautiful book, 'Heat, a Mode of Motion,' is a lesson of truth which has manifested far and wide through the world one of the greatest discoveries of modern philosophy. I have always admired it; I have long coveted it for Elasticity; and now, by kind permission of its inventor, I have borrowed it for this evening's discourse.

"A century and a half ago, Daniel Bernouilli shadowed forth the kinetic theory of the elasticity of gases, which has been accepted as truth by Joule, splendidly developed by Clausius and Maxwell, raised from statistics of the swayings of a crowd to observation and measurement of the free path of an individual atom in Tait and Dewar's explanation of Crookes's grand discovery of the radiometer, and in the vivid realisation of the old Lucretian torrents with which Crookes himself has followed up their explanation of his own earlier experiments; by which, less than two hundred years after its first discovery by Robert Boyle, 'the Spring of Air' is ascertained to be a mere statistical resultant of myriads of molecular collisions.

"But the molecules or atoms must have elasticity, and *this* elasticity must be explained by motion before the uncertain sound given forth in the title of the discourse, 'Elasticity Viewed as Possibly a Mode of Motion,' can be raised to the glorious certainty of 'Heat, a Mode of Motion.'"

The speaker referred to spinning tops, the child's rolling hoop, and the bicycle in rapid motion as cases of stiff, elastic-like firmness produced by motion; and showed experiments with gyrostats in which upright positions, utterly unstable without rotation, were maintained with a firmness, strength, and elasticity as might be produced by bands of steel. A flexible endless chain seemed rigid when caused to run rapidly round a pulley, and when caused to jump off the pulley, and let fall to the floor, stood stiffly upright for a time till its motion was lost by impact and friction of its links on the floor. A limp disc of india-rubber caused to rotate rapidly seemed to acquire the stiffness of a gigantic Rubens' hat-brim. A little wooden ball which when thrust down under still water jumped up again in a moment, remained down as if embedded in jelly when the water was caused to rotate rapidly, and sprang back as if the water had elasticity like that of jelly when it was struck by a stiff wire pushed down through the centre of the cork by which the glass vessel containing the water was filled. Lastly, large smoke rings discharged from a circular or elliptic aperture in a box were shown, by aid of the electric light, in their progress through the air of the theatre when undisturbed. Each ring was circular, and its motion was steady when the aperture from which it proceeded was circular, and when it was not disturbed by another ring. When one ring was sent obliquely after another the collision or approach to collision sent the two away in greatly changed directions, and each vibrating seemingly like an india-rubber band. When the aperture was elliptic each undisturbed ring was seen to be in a state of regular vibration from the beginning, and to continue so throughout its course across the lecture-room. Here, then, in water and air was elasticity as of an elastic solid, developed by mere motion. May not the elasticity of every ultimate atom of matter be thus explained? But this kinetic theory of matter is a dream, and can be nothing else, until it can explain chemical affinity, electricity, magnetism, gravitation, and the inertia of masses (that is, crowds of vortices).

Le Sage's theory might easily give an explanation of gravity and of it relation *to inertia of masses*, on the vortex theory, were it not for the essential aeolotropy of crystals, and the seemingly perfect isotropy of gravity. No finger-post pointing towards a way that can possibly lead to a surmounting of this difficulty, or a turning of its flank, has been discovered, or imagined as discoverable. Belief that no other theory of matter is possible is the only ground for anticipating that there is in store for the world another beautiful book to be called "Elasticity, a Mode of Motion."

SOCIETY OF MEDICAL OFFICERS OF HEALTH.

The Committee appointed to consider—

1. The best and most convenient method of dealing with animal and vegetable trade refuse (*e.g.*, from slaughterhouses, fishmongers', poulterers', greengrocers' shops, &c.), with a view to its collection, removal, and ultimate disposal, whether by utilisation or otherwise;
2. The collection and disposal of house refuse; and
3. The collection and disposal of stable and cowshed refuse,

beg to report as follows:—

1. *With respect to trade refuse.* The Metropolis Local Management Act (18 & 19 Vict., cap. 120, sect. 128) entitles the owner or occupier of any house or land to require the "scavenger" to remove the refuse of any trade, manufacture, or business, &c., on payment of a reasonable sum by way of compensation; but the Nuisance Authority, which by its own staff or by its "contractor" is the "scavenger" has at present no power to remove trade refuse, whatever its nature or condition, excepting on the requisition of the owner or occupier as aforesaid. The committee, however, are of opinion that as the refuse of slaughter-houses and the refuse of the trades of fishmonger, poulterer, greengrocer, &c., being of animal or vegetable origin and liable to decomposition, would, if not speedily removed from the premises, become a "nuisance and injurious to health,'

the Nuisance Authority should have power as well as obligation to collect, remove, and dispose of such refuse, and should receive reasonable compensation for so doing.

In the City of London, the Nuisance Authority (Commissioners of Sewers), as a matter of fact collect trade refuse—animal and vegetable—receiving payment; and the Committee are informed by the Medical Officer of Health, that the Commissioners have under consideration a scheme for its profitable utilisation—a scheme which is the more likely to succeed as the Commissioners will have to deal with large and regular supplies. It is open to question whether the Nuisance Authority in a district not having public markets could profitably utilise limited quantities of animal refuse directly; but possibly a scheme might be arranged for this purpose through the agency of establishments where "offensive trades" are carried on under the provisions of the Slaughter-houses Metropolis Act, 1874.

In any case the refuse should be collected daily in the early morning hours, and conveyed in properly constructed covered receptacles or in vehicles expressly adapted for the prevention of effluvium nuisance. Failing an arrangement for utilisation, each district should provide the means of destroying animal refuse. It appears doubtful whether vegetable refuse could be profitably utilised in London by the process of "carbonisation." The mere destruction of such refuse by fire could be effected without difficulty or nuisance.

2. *With respect to the Collection and Disposal of House Refuse.*—It is almost superfluous to observe that the Committee cannot approve of the refuse being deposited in large heaps or "tips" in or near towns or inhabited dwellings: its use for levelling land for building purposes is now very properly forbidden by the bye-laws regulating the foundations of buildings,* and its destruction in the open air, creating an intolerable nuisance, is impracticable.

The refuse, moreover, is not without value—the "breeze," for instance, being almost indispensable to the brickmaker. The value, however, has decreased of late years, for the growth of London has led to the production of the refuse in larger amount, while the increased distance to the brickfields has greatly increased the cost of carriage.

Formerly contractors were willing to pay large sums for the privilege of removing the contents of dust-bins. Now they invariably receive payment. The expense to the Nuisance Authority, however, is not so great as it would be were not the refuse capable of utilisation for various trade purposes. Of these the manufacture of bricks is the most important; and it is, perhaps, not too much to say that the diligence of the contractor in carrying out his contract is governed to no inconsiderable extent by the season of the year and by the demands of the brickmaker, so that the dust-bins are apt to be neglected when their contents are not in requisition in the brickfield.

The Committee consider, however, that the removal of house refuse ought not to depend upon its pecuniary value, but should be regarded from the sanitary rather than the commercial point of view, and they are of opinion that the time is at hand when the Nuisance Authority will have to adopt the process of refuse-destruction by fire, in specially constructed apparatus, such for instance as is in operation at many great provincial centres of population, as Birmingham, Leeds, Manchester, Warrington, &c., &c. The mere reduction in bulk resulting from this process (some 70 to 80 per cent) is in itself a great gain, so that in the event of no practicable means of utilising the products of combustion—slag and dust—being found, the quantity of perfectly innocuous matter to be disposed of would be relatively small. This is a very important factor in the cost, having regard to the limited facilities for water carriage, and to the exorbitant, not to say prohibitory, cost of railway carriage. The slag, however, is useful for making up roads; and ground into powder and mixed with lime it makes a valuable mortar, which in the provincial towns finds a ready sale at a remunerative price.

The combustion apparatus might be made available for the destruction of vegetable refuse and of infected articles; and probably it would suffice for the destruction of small quantities of animal refuse, failing any scheme for its "utilisation."

3. *With Respect to Stable and Cow-shed Refuse.*—The Nuisance Authority has power under the 53rd section of the Sanitary Act, 1866, to make regulations for the "periodical removal" by the owner, of manure, &c., and an ample penalty, twenty shillings per day, is provided for default. Nevertheless, when regulations exist they are rarely carried out strictly, for this reason among others, that it is found difficult to get Justices to inflict the penalties for neglect or default.

Of late years the difficulty of procuring the removal of the refuse has considerably increased, owing to the growth of London and the greater distances to the fields and market gardens. Formerly stable manure was in request by market gardeners, who paid a good price for it. Now, horse owners generally have to pay for its removal, or at best give it away. It is often difficult, moreover, to get it removed on any terms, for as a rule it is conveyed in vehicles returning from the markets; and at certain seasons of the year, *e.g.*, hay-making and harvest-time, it is practically impossible to get the farmers to send their carts so regularly as is necessary for compliance with the regulations.

"With the permission of the owner" the Nuisance Authosity may collect the refuse: but the Committee are of opinion that the Nuisance Authority should have the same right everywhere as in the City of London* to collect it when the owner is in default, and to charge him with the cost of so doing. There is good ground for believing that many horse owners would be glad to be relieved of the difficulty and responsibility of their position under the "regulations," and would be willing to pay a reasonable compensation to the Nuisance Authority to cover the cost of the removal of the refuse. The penalties for default of compliance with the regulations should be rigorously enforced against persons who fail to come to an arrangement with the Nuisance Authority.

Less difficulty is experienced in enforcing the removal of cow-shed refuse, this being further provided for by regulations framed under the "Dairies, Cow-sheds, and Milkshops Order, 1879;" the Nuisance Authority, moreover, being able to bring pressure to bear on offenders on the occasion of the annual application for the renewal of the cow-shed licence. The cow-keeper being thus compelled to incur the expense of removing his shed refuse regularly, would probably welcome any scheme whereby, without increased outlay, this duty would be taken off his hands by the Nuisance Authority.

The refuse of cowsheds should be removed within specified hours in the early morning, in vehicles specially constructed so as to prevent slopping and effluvium nuisance. It would be found difficult in some districts to remove stable refuse within the same hours, and the necessity for so doing would be less, provided it were found practicable to abolish sunken dung-pits, in which manure rapidly ferments and decomposes, giving rise to intolerable nuisance when the receptacle is emptied, and also in the passage of the cart through the streets. Were the plan universal of employing properly paved and drained receptacles enclosed within iron racks above the surface of the ground, so as to dry the refuse by air currents, its removal might be affected at any period of the day without offence, provided it had not been kept too long in the stable or in the receptacle itself, so as to become rotten and offensive.

The Committee having in the second and third sections dealt with the "collection" of trade and stable refuse,

* *Vide* Bye-laws made on Oct. 3rd, 1879, by the Metropolitan Board of Works, under the provisions of the Metropolis Management and Buildings Act, 1878, sec. 16.

* City of London Sewers Act, 1851, 14 and 15 Vic., cap. 91, sec. 8.

have now only to express their conviction that legislation will be found necessary to solve the difficulty attending the ultimate "disposal" of such refuse, viz., by imposing on canal and railway companies the obligation of conveying it from towns in boats and vans, expressly contrived for the avoidance of nuisance and at a rate for carriage which, while fairly remunerative, shall not be oppressive to the ratepayers—power to settle the rate, in case of dispute, to be vested in the railway commissioners or some similar tribunal having an equitable jurisdiction.

(*Signed*) T. Orme Dudfield, M.D., *Chairman.*
A. Wynter Blyth.
Alfred Carpenter, M.D.
Shirley F. Murphy.
Wm. Sedgwick Saunders, M.D.

April 21, 1881.

CORRESPONDENCE.

ESTIMATION OF FAT IN MILK.

To the Editor of the Chemical News.

Sir,—The inference to be drawn from the observations of those gentlemen who have been good enough to criticise my paper show clearly that the *modus operandi* of the process may vary directly with the ingenuity of the experimenter; and I think it is obvious enough, that whether we pass an elongated platinum dish or boat into the extractor, or attain the same end by the wilful destruction of a common watch-glass, the results are in no wise impaired. —I am, &c.,

William M. Hamlet, F.C.S.

London, May 25, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 16, April 18, 1881.

Action of Heat upon the Ammoniated Bases.—A. W. Hofmann.—On heating the hydroxide of an ammoniated base containing different radicles, it is observed that the methylic groups therein contained separate by preference in the state of tertiary bases, whatever may be the order of succession in the system, whilst another group (ethylic, amylic, &c.) leaves the system in the state of a carbide. Thus the hydroxide of methyl-diethyl-amyl-ammonium obtained by the action of methylic iodide upon diethyl-amylamine, and then treating the iodide obtained with silver oxide, is transformed into methyl-ethyl-amylamine and ethylene.

Secondary Battery of M. C. Faure.—E. Reynier.—This battery is derived from that of Planté; its electrodes are of lead, and are plunged into water acidulated with sulphuric acid; but its formation is deeper and more rapid. In the Planté battery the formation is limited by the thickness of the sheets of lead. M. Faure gives quickly to his elements an almost unlimited power of accumulation by covering the electrodes with a layer of spongy lead. The two lead plates of an element are individually covered with red lead, or some other insoluble oxide of lead. They are then enclosed in compartments of felt, kept firmly in their places by lead rivets, and the two electrodes are then placed, the one close to the other, in a receptacle containing acidulated water. The element is then traversed by an electric current, which brings the red lead to the state of peroxide upon the positive electrode, and reduces it to metallic lead upon the negative electrode. When the mass has been electrolysed the couple is formed and charged. When discharged the reduced lead is oxidised, and the peroxide of lead is reduced until the element becomes inert. It is then in condition to receive a new electric charge. A quantity of energy capable of performing the work of one horse-power may thus be stored up for an hour in a Faurê's battery of 75 kilos.

Action of Electrolysis upon Toluene.—A. Renard.—From pure toluene the author obtains a brown amorphous deliquescent body possessing all the properties of phenose. If the toluene submitted to electrolysis contains benzine the phenose is accompanied by benzo-glycol.

Chemisches Central-blatt.
Vol. 11. No. 37.

Absorption of Radiant Heat in Gases and Fats.—E. Lecher and J. M. Pernter.—The absorptive power of the bodies examined, belonging to the fatty series, for the radiation of a source of heat at 100° is as follows:—Methylic alcohol, formic acid, carbonic oxide, carbonic acid, chloroform, II. ethylic alcohol, acetic acid, ethylic ether, ethyline, III. butylic alcohol, IV. amylic alcohol. Whilst the absorption in each series is approximately equal it increases rapidly with the proportion of carbon.—*Wiener Anzeiger.*

Theory of the Galvanic Element.—F. Exner.—The author shows that between metals and liquids, where no chemical action takes place, there is no more electric separative power than between two metals. The entire effect of a galvanic element depends exclusively on the chemical action.—*Wiener Anzeiger.*

Double Decomposition in the Absence of Water.—A. Potilitzin.—The author's experiments refer to potassium, sodium, and silver bromides, and dry hydrochloric acid. During the reaction heat becomes latent. The quantities of bromine replaced by chlorine are inversely proportional to the atomic weights of the metals, and run counter to the rule of maximum work.

Action of Aluminium Chloride and Bromide upon Carbon Compounds.—J. Gustavson.—Many compound ethers combine with aluminium chloride and bromide.

MEETINGS FOR THE WEEK.

Saturday, 28th.—Physical, 3. "On the Change of State from Solid to Liquid," Prof. Poynting. "Illustrations of Fresnel's Theory," C. J. Woodward.
Tuesday, 31st.—Civil Engineers, 8.
—— Royal Institution, 3 p.m. "Non-Metallic Elements," Prof. Dewar.
Thursday, June 2nd.—Royal Institution, 3. "Magnetism," Professor Tyndall.
—— Royal Society Club, 6.30.
—— Chemical, 8. "On the Saponification of Fatty Acids and Waxes," A. H. Allen and W. Thomson. "On the Sulphides of Copper and a Determination of their Molecular Weight," Spencer Pickering.
Friday, 3rd.—Royal Institution, 8. "Magnetic Disturbance, Auroræ, and Earth Currents," Professor W. G. Adams, 9.
—— Geologists' Association, 8.
Saturday, 4th.—Royal Institution, 3. "Russian Literature: Gogol," Prof. C. E. Turner.

Erratum.—P. 210, col. 2, line 27 from top, *for* 140° C. *read* 104° C.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1123.

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF WHITE AND COLOURED LIGHT.*

By Dr. J. YOUNG, F.R.S., and Professor G. FORBES.

The method employed in this research to measure the velocity of light resembled the method of M. Fizeau, subsequently employed by M. Cornu. A revolving toothed wheel is employed in the same way to alter the intensity of the light reflected from a distance. In the present method, however, there are two distant reflectors instead of only one. They are separated by a distance of a quarter of a mile. The observing telescope and the two reflectors are almost in the same line. The observer sees two stars of light, which go through their phases with different periods as the toothed wheel is revolved at increasing speeds. One star is increasing, while the other is diminishing, in intensity, with increase of speed of the toothed wheel. The speed required to produce equality of the lights is determined by means of a chronograph.

By choosing such a speed as gives a maximum of one star at the same speed as a minimum of the other, a pair of observations eliminates all cause of doubt arising from varying brightness in the stars, and ratio of the width of a tooth to the width of a space. The distances were observed by triangulation with the Ordnance Survey 18-inch theodolite, using as a base line a side of one of the Ordnance Survey triangles. The source of light was an electric lamp. The velocities (uncorrected for rate of clock, and reduction to a vacuum) measured are as follows:—

187,707
188,405
187,676
186,457
185,788
186,495
187,003
186,190
186,830
187,266
188,110
188,079

Mean .. 187,167 miles a second.

The correction to vacuum is +54 miles a second. The correction for rate of clock to a mean solar time is +52 miles a second.

The final results for the velocity of the light from an electric lamp *in vacuo* is 187,273 miles a second, or 301,382 kilometres a second.

Using Struve's constant of aberration 20·445", we obtain for the solar parallax the value 8·77", and for the mean distance of the sun 93,223,000 miles.

On February 11th, 1881, the reflected stars were seen to be coloured, one reddish, the other bluish. The particular colour of a particular star depended upon the speed of rotation of the toothed wheel. That star which was increasing with increase of speed of the toothed wheel was reddish, that one which was diminishing with increase of speed was bluish. This seems to be caused by the fact that blue rays travels quicker than red rays.

A number of tests were made to judge of the accuracy of this conclusion, and they confirmed it. In the final arrangements, the electric light was acted upon by a bisulphide of carbon prism, and part of a pure spectrum was used. Differential measurements were then made to find the difference in velocity of rotation of the toothed wheel, required to produce equality of red and of blue lights. The most convenient method was to use a driving weight slightly in excess of that required to produce equality of the light, then to fix to the pulley carrying the weights one end of a piece of stout india-rubber tubing, the other end being fixed to a point above. This gradually diminished the effective driving weight. The equality of red lights was first noted, the colour of the light was changed, and the interval of time until the blue lights were equal was measured. The rate at which the india-rubber diminished the speed was afterwards measured by the aid of the chronograph, and thus the difference of speed determined. The mean of 37 determinations in this and other ways gave the result that the difference in velocity between red and blue lights is about 1·8 per cent of the whole velocity, blue travelling most rapidly.

The general conclusion seems to be supported by a comparison of the velocity of light measured by M. Cornu and Mr. Michelson, where the source of light usually employed is taken into consideration. These are the only accurate measurements of the velocity of light hitherto published. They give us the following results:—

	Usual source of Light.	Velocity in kilos. a Second.
Michelson's research..	The sun near horizon	299,940
Cornu's ,, ..	Lime light	300,400
The present ,, ..	Electric light	301,382

Classifying the sources of light used by Cornu, we get the following approximate relative velocities:—

Source of Light.	No. of Observations.	Approximate Relative Velocity.
Petroleum	20	298,776 kilos.
Sun near horizon ..	77	300,242 ,,
Lime light	449	300,290 ,,

All these results seem to support the view that the more refrangible the source of light, the greater is the velocity. But the evidence of the present observations, indicating an excess of velocity for blue over red light, seeming to exceed 1 per cent of the whole, must rest upon the merit of the present observations themselves.

* Abstract of a paper read before the Royal Society, March 19, 1881.

ON THE ESTIMATION OF PEROXIDE OF HYDROGEN.

(Answer to the Reply of Mr. C. T. Kingzett.)

By EM. SCHÖNE.

Mr. Kingzett has published a "reply" (Chemical News, vol. xliii., p. 161) to my "Remarks" (p. 149) on his "Report on the Atmospheric Oxidation of Phosphorus, &c." (*Jour. Chem. Soc.*, vol. xxxvii., p. 792), on which I, in my turn, will make the following observations:—

I. In his "Report" Mr. Kingzett corrects his error, and agrees with me in saying that *an exactly neutralised solution of peroxide of hydrogen liberates iodine from KI.*

II. Mr. Kingzett, like me, finds (Chemical News, vol. xliii., p. 161) that (in slightly diluted solutions) the quantity of iodine liberated is insignificant in comparison with the quantity of peroxide of hydrogen (*Ibid.*, p. 149) that the solution becomes alkaline, and (*Jour. Chem. Soc.*, vol. xxxvii., p. 792) that the principal portion of peroxide of hydrogen undergoes decomposition into water and free oxygen, viz., undergoes so-called "catalytic" decomposition.*

* By "catalytic," for brevity, I mean such a decomposition as, when it ceases, leaves the body, by which it was excited, in its primi-

III. In my detailed treatise in *Liebig's Annalen*, vol. cxcv., p. 228 to 252, I stated that the relative quantity of peroxide which undergoes this "catalytic" decomposition decreases in proportion to the increase of the dilution; and, beginning from a certain limit, we no more perceive the evolution of oxygen, whilst the liberation of iodine continues. When by further dilution the quantity of H_2O_2 in 1 litre becomes less than 1 milligrm, the liberated iodine produces with starch, colourations, the intensity of which decreases with the increase of the dilution.* On this last *fact*—not on a supposition, as Mr. Kingzett thinks—is based my colorimetric method of the estimation of peroxide in solutions containing from 0·08 to 1·0 milligrm. H_2O_2 in 1 litre.

IV. In my treatise in *Liebig's Annalen* (vol. cxcv.) I have devoted about five pages (243 to 248) to a detailed explanation of all the facts observed in the mutual action of H_2O_2 and KI in neutral solutions. In my "Remarks" I begged Mr. Kingzett to read my original paper before criticising it. However, from his recent "Reply" it is plain that as yet he has not become acquainted with my detailed treatise, though he continues criticising it. Out of all my explanations of the facts occupying the aforesaid five pages he knows only the four equations which he found in the very short and incomplete abstract in the *Journal of the Chemical Society*, vol. xxxvi., p. 353. At the same time he exclaims—". . . four reactions, supposed by Mr. Schöne to represent the whole truth!" Thus expresses himself a gentleman who has not read what he criticises, and who but a short time ago was not able to distinguish ozone (produced by the slow oxidation of phosphorus) from peroxide of hydrogen. Upon the strength of this I think that I have a right to dispute the competency of my critic, and to protest against such a superficial, unscientific treatment of the serious scientific work of others.

V. It seems to Mr. Kingzett as if the presence of free oxygen in dilute solutions of peroxide of hydrogen—for instance, in atmospheric aqueous precipitation—does not admit an exact determination of peroxide by the colorimetric method offered by me. If, instead of discussing, Mr. Kingzett would make in his laboratory, "with ease and accuracy," a slight experiment he would be easily convinced as to the truth of the fact—which, besides, is well known—that common oxygen (in the dark) has no effect whatever on a solution of neutral potassic iodide (containing starch), consequently that the presence of free oxygen in a solution does not in any case offer a source of error in the determination of peroxide by my method.

VI. Mr. Kingzett presupposes the just-mentioned source of error, because I, in my explanation of the mutual action of KI and H_2O_2 admit, amongst other things, the dissociation of potassic iodide with water—

$$KI + H_2O = HI + KOH$$

(*Liebig's Annalen*, cxcv., 244, and cxciii., 257, in footnotes). He thinks that, if HI had existed in the solution, the oxygen likewise contained in it ought to have set iodine free. Indeed, oxygen decomposes HI in the presence of acids, or of hydriodic acid itself, or some other acid. But in this case a base is present: caustic potash capable of neutralising iodide of hydrogen. And the non-decomposition of iodide of hydrogen by oxygen can be explained by the presence of that alkali. That the presence of these or other substances, especially acids and bases, modifies many reactions there are many examples. I will refer here only to the two following examples relative to the compounds in question:—

Example 1.—Peroxide of hydrogen and peroxide of manganese act on each other differently, in the presence or in the absence of acid.

In the absence of acids peroxide of hydrogen alone is reduced—

$$(MnO_2) + H_2O_2 = (MnO_2) + H_2O + O.$$

In the presence of acids peroxide of hydrogen produces a reduction of peroxide of manganese—

$$MnO_2 + H_2O_2 + H_2SO_4 = MnSO_4 + O_2 + 2H_2O.$$

In the presence of a base peroxide of hydrogen, on the contrary, oxidises the manganous oxide and produces peroxide—

$$(KOH) + MnO + H_2O_2 = (KOH) + MnO_2 + H_2O.$$

Example 2.—Schönbein has shown (*Journal für Praktische Chemie*, lxxxi., 276) that potassic iodide possesses the power of preserving free iodine from the action of the free caustic potash.

Further examples can be found, amongst other things, in the treatises of Lenssen:—"Die Alkalipathischen Oxydationsagentien" (*Ibid.*, lxxxii., 293), and "Die Acidipathschen Oxydationsagentien" (*Ibid.*, lxxxiv., 393).

Thus the fact that free oxygen does not liberate iodine in solutions of neutral potassic iodide does not in the least contradict the dissociation of potassic iodide with water when dissolved in the latter.

VII. Touching what Mr. Kingzett states in his "Reply" in defence of his own method, I find it superfluous to speak about it again. It will suffice to refer to what was said by me relative to that subject in my "Remarks" on his "Report." I will only observe that I do not see any essential difference between Mr. Kingzett's "reasonable large" excess and "ridiculously great" excess of acid, as the experimental ciphers, given by Mr. Kingzett himself, show that the results obtained by both excesses do not essentially differ one from another. In conclusion, concerning the accuracy of the estimation of peroxide of hydrogen by means of the two methods employed by Mr. Kingzett (*Jour. Chem. Soc.*, xxxvii., 807)—namely, "The $KMnO_4$ method" (*without* acid) and "The neutral bichromate method"—I cannot forbear expressing great doubts, having in view, at least, the investigations of Weltzein, Swiontkowski, Aschoff, Brodie, and others about this process.

Petrowskoye Rasumowskoye, near Moscow.
May 5-17, 1881.

ON THE

ELIMINATION OF CARBON DISULPHIDE FROM COMMERCIAL BENZOLS BY ALCOHOLIC POTASH.

By BENJAMIN NICKELS.

SINCE referring to this reaction (see CHEMICAL NEWS, vol. xliii., p. 148) I have received several enquiries for more detailed accounts concerning the precise method of conducting the test, together with limits (if any) of bisulphide removal.

The following examples selected from a great number of trials will serve to afford the information required, and at the same time to illustrate more clearly the details of the operation:—

One of the last experiments made was with a very pure toluol, not having, at the time, benzol of equal purity at disposal; its sp. gr. at 15·5° C. was 0·871, and its boiling-points 109½° to 111° C. 99 c.c. of this toluol and 1 c.c. of carbon bisulphide, equal to 1¼ per cent by weight, were mixed for examination; its sp. gr. was 0·875 at 15·5 C. To this was added 1 grm. of potassium hydrate previously powdered, and dissolved in the smallest quantity of boiling absolute alcohol. On agitating the mixture, it instantly became very yellow, and, at the expiration of about one

tive form, not acknowledging, however, by it a catalytic force in the sense used by Berzelius. I cite here the following words from my treatise (*Liebig's Annalen*, 195, 245). "In this case, however, the "catalysis" is incomplete, inasmuch as some of the intermediate products of the decomposition of the substance causing the catalysis, namely, a part of iodine and caustic potash—as the experiment shows—remains."

† In diluted solutions the liberation of iodine is produced slowly, in consequence of which the maximum of the colouration is reached only after the lapse of five or six hours.

minute, pasty, from the formation and separation of potassium xanthate, which assumed a highly crystalline and silky appearance, very characteristic of the compound and impossible to be mistaken. The mixture was allowed to digest with occasional shaking during half an hour, at the expiration of which it was filtered. The fluid or toluol portion was then placed in a glass separating funnel, closed with a stopper, and washed by brisk agitation with its own volume of slightly warm water (in order to facilitate the more rapid separation of the toluol under treatment). After allowing to rest for a few minutes, the wash-water containing the alcohol originally present in the mixture together with a little dissolved potassium xanthate, was run off by the glass tap, and the washing operation again repeated with a like quantity of cold water; the toluol was then run off into a dry bottle and agitated with a little plaster-of-Paris to dehydrate, and finally submitted to examination; its sp. gr. was found to be 0·872, or 1° higher than the original toluol, *i.e.*, 0·871, and which showed that the whole of the bisulphide had not been removed by the treatment; the weight of the dried precipitate of xanthate obtained in the experiment also indicated a deficiency, according to the reaction.

$$\underbrace{C_2H_5HO}_{46}+\underbrace{KHO}_{56}+\underbrace{CS_2}_{76}=\underbrace{KC_2H_5COS_2}_{160}+\underbrace{H_2O}_{18}.$$

160 parts of potassium xanthate contain 76 parts of bisulphide, or nearly one-half, and which requires for every one part of bisulphide removed 0·74 part of potassium hydrate. The 1 grm. of that reagent employed in the experiment should have been sufficient to have removed the whole of the bisulphide present, but as the potassium xanthate obtained weighed 1·82 grms. only, it showed 0·91 in place of 1·270=71·6 per cent. The boiling-points on 100 c.c. of the resultant toluol also indicated that it contained a little bisulphide, and which will be observed on comparing the appended figures.

Toluol originally used. Sp. gr., 0·871.		After Alcoholic Potass Treatment. Sp. gr., 0·872.	
At 109·5° C. ..	5 per cent over.	At 107·0° C. ..	5 p.c.
109·6 ..	10 ,, ,,	107·8 ..	10 ,,
109·8 ..	20 ,, ,,	108 8 ..	20 ,,
110 ..	30 ,, ,,	109·8 ..	30 ,,
110·1 ..	40 ,, ,,	110·1 ..	40 ,,
110·2 ..	50 ,, ,,	110·2 ..	50 ,,
110·4 ..	60 ,, ,,	110·4 ..	60 ,,
110 5 ..	70 ,, ,,	110·4 ..	70 ,,
110·6 ..	80 ,, ,,	110·5 ..	80 ,,
110·7 ..	90 ,, ,,	110·6 ..	90 ,,
111·1 ..	95 ,, ,,	111 ..	95 ,,

The presence of bisulphide in the fluid so treated is, I may add, indicated by the heavier sp. gr. and lighter boiling-points noticeable in the first distillates recorded (5 to 30 per cent). The mixture was then subjected to a second treatment with a diminished quantity of potash, 0·5 grm. only in alcoholic solution, and, on agitating, a further colourisation and deposit of xanthate was obtained. At the expiration of half an hour, it was filtered off, washed, and dehydrated as before; its sp. gr. was found to be 0·871, agreeing with the toluol originally taken, and the boiling-points differing only by fractions in the first 15 per cent over.

In order to set the question at rest the fluid was treated a third time with a similar quantity of alcoholic potass, and washed in like manner. No yellow colourisation resulted, nor was potassium xanthate formed, but merely a deposit of amorphous and unaltered potash. This was ultimately filtered off, and, after washing and dehydrating, the toluol showed unaltered sp. gr. and boiling-points, and from which I concluded that the whole of the bisulphide originally introduced within perhaps a minute fraction had been removed.

I may add that in taking the boiling-points I used one of the new fractioning tubes, or "miniature columns," as supplied by Messrs. Townson and Mercer, of Bishopsgate Street, a very marvel of glass-blowing, and a piece of apparatus most effective in benzol fractioning. I have found that 70 per cent at least of the bisulphide and light hydrocarbons contained in ordinary 90 per cent commercial of English make may by its use be concentrated in the first 8 c.c. fractioned out. These instruments I am informed are becoming very much used for the purpose on the Continent. I need hardly say the temperatures were recorded with the bulb of the thermometer immersed in the vapour, and at a distance of about 12 inches from the flask containing the 100 c.c. of fluid under trial, the ordinary method of retort boiling with immersed thermometer being altogether too crude and wide for anything like accurate determinations.

As regards the use of these instruments when substituted for the retort in ordinary benzol boiling, I have not found them of much utility; on the other hand, in fractioning and separating the constituents of a given sample, their performance is perfect. After removal of "bisulphide" by alcoholic potash, the light hydrocarbons, sp. gr. 0·860, are easily separated, and benzol and toluol follow with such facility that no difficulty is experienced in making a fairly complete analysis.

ON THE DETERMINATION OF POTASSIUM AS POTASSIUM PLATINO-CHLORIDE.

By Dr. ZUCKSCHWERDT and Dr. WEST.

On May 1, 1880, Mr. R. R. Tatlock sent a circular to the potash manufacturers of Germany, in which he describes and recommends his method for the determination of potassium in potash salts. His process is as follows:—

"Dissolve 35 grms. of the sample in water, filter if needful, and dilute to 500 c.c. Put 10 c.c. of the solution in a small porcelain capsule, add 20 c.c. water, stir, and add 30 c.c. of a solution of platinum chloride containing in 100 c.c. 7 grms. platinum. Evaporate in the water-bath, but not to complete dryness, add a few drops of water, evaporate again, treat the precipitate with 2 c.c. of the platinum solution, stirring well; pour on a filter, wash it on the filter with 1 c.c. of the platinum solution, and wash the capsule, the filter, and its contents with a minimum of alcohol at 93 per cent. Dry the filter in the water-bath, bring the precipitate as completely as possible into a small platinum capsule, dry at 100°, and weigh. The filter with adhering traces of the precipitate is incinerated, the residue is weighed, calculated as potassium platino-chloride, and the weight thus obtained is added to quantity of the latter compound already obtained."

At the request of the potassium chloride manufacturers of Leopoldshall and Stassfurt we have examined Tatlock's process closely, and compared it with the method generally used in these works.

The potassium chloride employed in the analyses was found to be perfectly pure by demonstrating the absence of foreign matter. As a further precaution some analyses were made with a potassium chloride specially prepared as follows:—The pure chloride just mentioned was dissolved and mixed with platinum chloride, the liquid, containing excess of platinum chloride, poured off, and chemically pure potassium chloride obtained from the precipitate by ignition, extraction with water, evaporation, and repetition of these processes.

The results according to Tatlock's method were on the average 0·35 per cent too low, whilst those obtained by the method here customary come sufficiently near the truth. The explanation of this deficiency is as follows:—

1. Platinum chloride dissolves potassium platino-

chloride in appreciable quantities: 100 c.c. of a solution of 7 grms. platinum in 100 c.c. dissolved, on agitation for thirty hours on the fly-wheel of a steam-engine, 0·3250 grm. of the double chloride. More concentrated solutions do not dissolve so much; but the error is still so considerable that the first drops of Tatlock's filtrate are rendered turbid by the addition of absolute alcohol, and deposit potassium platino-chloride in microscopic crystals.

2. During the incineration of the filter there is a sensible loss from the evaporation of potassium chloride, depending on the quantity of the precipitate which has adhered to the filter. According to the authors' analysis this loss amounts on an average to 0·1 per cent potassium chloride.

In addition to these two evident sources of error—the magnitude of which Mr. Tatlock seems to admit, otherwise he could not regard a result of 99·5 per cent in chemically pure potassium chloride as admissible—the process has several minor defects which are here mentioned in brief.

1. The measurement of 10 c.c. of a solution of 35 grms. in 500 c.c. is a very difficult task. The loss of one drop (=1-20th c.c.) gives an error of 0·5 per cent KCl in a salt of 100 per cent. Perhaps it might be prudent, in order to reduce this source of error, to dissolve a smaller weight of the salt in 500 c.c., or to dissolve 35 grms. in a larger vessel, if it is desirable to work with such large quantities. Tatlock dilutes his solution afterwards by the addition of water.

2. Mr. Tatlock pours the contents of the porcelain capsule which has been used for evaporation upon a filter, with the aid first of 2 and then of 1 c.c. platinum chloride, and washes them with alcohol. According to experience here—and probably everywhere—decantation, especially for large quantities of precipitate, is the safer and more rapid method of washing.

3. Tatlock uses an enormous excess of platinum chloride; whilst 0·7 grm. potassium chloride requires only 0·925 grm. of platinum, he takes 2·100, unless we have here a printing fault or an error in calculation. For this he does not give a reason, but it lies probably in the slight solubility of potassium platino-chloride in platinum chloride, since the presence of sodium chloride in a commercial sample cannot justify such an excess. Even 0·7 sodium chloride would only consume 1·180 platinum, or little more than half of prescribed quantity. Why this extravagance in the use of platinum chloride when the object can be attained with alcohol, which is cheaper, and in which all the platinum double salts likely to occur in ordinary analyses are completely soluble? And the use of alcohol after all is not dispensed with!

According to our opinion Tatlock's method gives inaccurate results in consequence of the above-mentioned errors and deficiencies, and should hence be completely rejected.

The method of Fresenius gives perfectly accurate results, but it is too tedious for practice, and we therefore must prefer the method which is in general use in the works of Leopoldshall and Stassfurt, which is as follows:—

10 grms. of a well-mixed sample are dissolved in a 500 c.c. flask, filled up to the mark, shaken, an aliquot part filtered, and 20 c.c. (=0·4 grm.) measured off. This is mixed in a porcelain capsule with 7 c.c. of a solution of platinum chloride containing 10 grs. platinum in 100 c.c.

As commercial samples rarely contain more than 20 per cent sodium chloride, whilst the above quantity of platinum would suffice for 0·4 grm. of sodium chloride at 100 per cent, there is always a considerable excess of platinum chloride present.

The contents of the capsule are then evaporated on the water-bath to the consistence of syrup with frequent stirring, so that when cold the mass appears dry. The free hydrochloric acid is thus chiefly expelled. When cold the mass is covered with 10 c.c. of alcohol at 95 per cent, well rubbed up with a glass rod, and the washings are poured upon a balanced filter. Alcohol is again spirted on, in smaller quantity: the mass is again rubbed up, the washings poured off, and the operation is repeated once more. As a rule, at the second decantation the colour of the washings, and consequently the proportion of the platinum double salt, will be very slight, and in the third operation it disappears altogether; otherwise the operation must be repeated once more. The precipitate, which now consists of perfectly pure potassium platino-chloride, is brought upon the filter by means of the alcohol washing-bottle, and after drying for half an hour at 110° to 115°, it is weighed under the same conditions as it had been when empty.

The total quantity of alcohol consumed is in general 50 c.c. The errors fall within the narrowest limits of permissible experimental errors, and could scarcely be removed or avoided by greater complication.—*Zeitschrift für Analytische Chemie.*

ON THE ATOMIC WEIGHT OF PLATINUM.

By K. SEUBERT.

The irregularities which upon averaging the periodic system have become apparent in that group of the eighth family which includes osmium, iridium, and platinum, render a revision of these atomic weights very desirable. The author has therefore undertaken a re-determination of the atomic weight of platinum.

This weight has hitherto been assumed at about 197, the statements ranging from 196 to 198. The analysis of potassium platino-chloride executed by Berzelius gave, according to the manner of calculation, Pt=196·705 to 197·234. Andrews, from the relation of total chlorine in the above-mentioned salt to the proportion of metal, found an average value of 197·88. There is also an almost forgotten experiment of Berzelius, in which by reducing platinous chloride he found Pt=194·177. According to the periodic law, instead of the series as assumed at present, Ir<Au<Pt<Os, the arrangement Os<Ir<Pt<Au would appear more probable. Since the atomic weight of gold, Au=196·2, has been determined with tolerable accuracy, it seemed probable that the atomic weight of platinum must be less than 196. For the determination of this weight the author selected the double salts of the tetrachloride with ammonium and potassium chlorides. The average value, as deduced from four analyses ranging from 194·35362 to 194·60576, was Pt=194·46124. Reduction to a vacuum alters this result to 194·34050. The composition of the potassium salt is consequently:—

			Per cent Calculated.	Per cent Found.
Pt	=	194·46	40·119	40·110
2KCl	=	148·79	30·697	30·685
Cl_4	=	141·46	29·184	29·211
		484·71	100·000	100·006

Hence platinum takes the serial position Ir<Pt<Au which its properties, considered as a function of the atomic weight, demand.—*Berichte der Deutschen Chemischen Gesellschaft.*

The Alkaloids of Belladonna, Datura, Hyoscyamus, and Duboisia.—A. Ladenburg.—*Atropa belladonna* contains at least two alkaloids which may be provisionally distinguished as heavy and light atropine, the light kind being identical with hyoscyamine. *Datura stramonium* contains also two bases, a light and a heavy; the former is the more abundant, and the latter a mixture of atropine and hyoscyamine. The light daturine is identical with hyoscyamine. Hyoscyamus contains two bases, the one crystalline and the other amorphous.—*Berichte der Deutschen Chemischen Gesellschaft.*

ON THE

VOLUMETRIC DETERMINATION OF CHROMIUM AND MANGANESE ALONG WITH FERRIC OXIDE AND ALUMINA.

By E. DONATH.

Permanganate has hitherto been used in volumetric analysis only in titrations performed in neutral or acid solutions, and in such a manner that the permanganate solution is run into the liquid to be examined till a red colouration appears. But if we proceed inversely, adding the liquid to be tested to a strongly alkaline and hot permanganate solution (which has an energetic oxidising action), several metals may be determined, which form oxides capable of higher oxidation by the alkaline permanganate solution, in the presence of other metals whose oxides are simply precipitated by the alkali, but are not further oxidised by the permanganate, and have upon it no reducing action.

Among many cases of this kind the author has examined more closely a determination very important in a technical respect—that of chromium and manganese in presence of iron and alumina.

If a solution of permanganate is made strongly alkaline with sodium carbonate and a little caustic soda, heated to a boil, and a neutral solution of chromic oxide is run in, the chromic oxide is at once converted into chromic acid, whilst manganese peroxide is separated out. The process is completed when the supernatant fluid has the pure yellow tint of alkaline chromates without the slightest reddish tinge, which may be recognised with sufficient distinctness.

The presence even of considerable quantities of ferric oxide and alumina in the solution containing the chrome does not prevent the completion of the reaction from being distinguished, since these oxides, if precipitated in heat, are rapidly deposited along with the manganese peroxide. If the approximate relation of the alkaline permanganate to the chrome solution in question has been determined by a preliminary experiment, on further titration the end of the reaction can be observed with sufficient accuracy. In fact the volumetric determination of chromium is in this manner rendered possible without the previous separation of iron and alumina.

If the neutral solution of a manganese salt is allowed to flow into the hot alkaline permanganate a precipitate is formed at once, containing the manganese of both the solutions. The process is at an end when the supernatant liquid is colourless.—*Berichte der Deutschen Chemischen Gesellschaft.*

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,

Member of the American Society of Civil Engineers.

It is not too great an admission to say that the Ventilation of Halls of Audience—that is, assembly-rooms, lecture-rooms, churches, theatres, and similar places—has not yet been generally effected in the most satisfactory manner.

All rooms, where many people are gathered together, are liable to become more or less offensive after a brief duration of session, and noticeably more objectionable as the session lengthens.

The flippant writer who records and publishes the circumstances does not hesitate to ascribe the defect to "want of scientific knowledge," with the implication that either he himself possesses or that he can readily produce the encyclopædia which contains such information. Those who have practically to do with the erection of buildings or the construction of apparatus for ventilating and warming the same, and especially those in whose charge the finished buildings and their apparatus are placed, are well aware that the teachings of the books or the records of practice have not gone beyond the studies of requirements, most frequently under conditions not applicable to our climate of the northern United States; or further than an incomplete description of the details of apparatus, which certainly have been evolved in a very perfect way in the workshop. In this regard of apparatus as a whole, it may be averred at once that, for more than twenty years, the practice of American contractors has been such as will meet every requirement of supply of air in any quantity and at any temperature desired.

The literature of ventilation is tolerably voluminous, but a few books, now over a quarter of a century old, give with much uniformity of repetition all that is written on the subject.*

Most writers are diffuse. The theory of ventilation has been based upon considerations rather than investigations. Views have to be supported in lieu of facts ascertained. The experiments and observations in the direction of chemical or pathological inquiry have, in a great measure, failed to give results compatible with evident physical wants. Ventilation of occupied places, in general, means only the supply of air for health and comfort in requisite quantities. But the uncertain element in this simple proposition is, what quantities are requisite?

The real quantity of air impaired by any one individual is small in any case, although it varies in amount with all the conditions of life and health of the individual, especially also for any one individual as to rest or activity, until limits three times in excess and one-half in diminution of what is impaired in the state of comparative rest are reached.

In air, at mean temperature of 60 to 70 per cent of hygrometry, an adult man, when awake and at rest at his ease, in similar condition in general to one of an audience in a public hall, may be taken to make sixteen respirations, of 30 cubic inches each, or 480 cubic inches, in a minute.† This inhaled air at say 70 degrees will have, when in American summer condition of humidity, about 70 per cent of complete saturation, or about $1\frac{1}{8}$ per cent of its volume will be aqueous vapour, and about $\frac{4}{100}$ of a per cent of its volume will be carbonic acid, while the remainder will be nitrogen and oxygen in the usual constant ratio of about four to one which exists everywhere in the atmosphere. The exhaled air will be found to have lost about one-fifth the oxygen inhaled, by the formation of carbonic acid; it will have nearly three times as much aqueous vapour, and nearly a hundred times as much, or about 4 per cent of its volume, of carbonic acid; while, notwithstanding the greater density of this carbonic acid gas, in consequence of the increase of temperature from 70 degrees to 90 degrees, and also of the levity of the

* A paper presented to the American Society of Civil Engineers, January 26, 1881.

* "A Course of Experimental Philosophy," by Dr. Desaguilliers, London, 1723; "Conducting Air by Forced Ventilation," by the Marquis de Chabannes, London, 1818; "Principles of Warming and Ventilation," by Thomas Tredgold, London, 1824; "Theory and Practice of Warming and Ventilating," by an Engineer (anon.), London, 1825; "Popular Treatise of Warming and Ventilation," by Charles James Richardson, London, 1839-56; "Practical Treatise on Warming of Buildings, &c.," by Charles Hood, London, 1844; "Illustrations of Ventilation," by Dr. David Boswell Reid, London, 1844; "Dictionary of Arts, &c.," by Dr. Andrew Ure, London, 1846; "Practical Treatise on Ventilation," by Dr. Morrell Wyman, Boston, 1846; "Traité de la Chaleur," par E. Péclet, Paris, 1843-60; "Etudes sur la Ventilation," par Gen. Arthur Morin, Paris, 1863.

The above is merely a list of the more important works. A complete list for this century is perhaps fifty volumes, mostly since 1850, with possibly important articles in a hundred periodical or serial publications. It is proper that the most valuable recent work should be named, wherein the physiology of ventilation is most clearly set forth; to wit, "Military Hygiene," by Dr. Edmund Parkes, London, 1863. The last edition of this work is edited and enlarged by Dr. F. S. B. François de Chaumont, London, 1878.

The indispensable library books of reference in the above are Wyman, Péclet, Parkes, Reid, Tredgold, Hood. . . .

† Experiments of Dr. Edward Smith. *Proc. Roy. Soc.*, 1859.

aqueous vapour, the exhaled air is really about 3 per cent lighter than the inhaled air.

This statement of the figures of respiration has been carefully prepared, and may be implicitly relied upon. It is presented in the outset of this paper as a foundation on which to build much of the argument to follow, and is especially intended to meet two popular fallacies.

The opinion is entertained by many people, some of whom ought to have informed themselves better, that the expired breath is heavier than the air, and, as a heavier body, it falls to the ground. The contrary is certainly the case. Notwithstanding the direction given to the breath when breathing from the nostrils, the column of breath ascends in all places where the temperature of the air is below 15 degrees. The diffusion of the exhaled breath—that is, the mixture into air near by—will of course take place nearer to any person when the flowing off of the stream of exhalation is impeded by the want of difference of temperature between the breath and the air. In any room at the temperature of comfort, 70 degrees to 72 degrees (with proper humidity), the diffusion of the breath will occur above the heads of the persons, and the fresh air for inhalation will be derived from the current ascending along the person—a current induced in part by the ascensive force of the expired air, and in part by the bodily heat of the person himself. This assertion is to be qualified, however, by admission of effect from established or enforced currents of artificial ventilation, which may modify, or even reverse, the natural flow.

The second popular error is, that the carbonic acid of itself separates and falls to the ground by virtue of its greater specific gravity (as a pure gas) than that of air. This is altogether a mistake. Carbonic acid has a density as compared with dry air of the same temperature, of 1·524 to 1. It can be poured from one vessel to another as water is poured, but for all that it "diffuses" or dissipates itself very rapidly, and when once diffused no length of time effects the least settlement or separation. There will be no less carbonic acid at the top of a tube 100 feet high than at the bottom. Carbonic acid, if colder than the air above it, will diffuse more slowly; if warmer than the air near it, so as to be more close to the same specific gravity, it will diffuse more rapidly. Whisky will lay on the top of water without mixing downwards; but once mixed with water, nothing but distillation will separate the two liquors. In point of fact the carbonic acid emitted with the breath is thoroughly, completely, and inseparably mixed with the breath; and the expired breath itself, as a whole, is rapidly, almost instantaneously, absorbed and inseparably mixed with the air of the room.

A man vitiates more air than is needed for respiration; an uncertain quantity of fresh air is both needed and vitiated in each minute by transpiration. A constant exhalation of carbonic acid transpires from the skin, by no means so large as that emitted from the breath, but probably one-fourth or one-fifth as great. The regularity of this transpiration nearly equals that of respiration. Accompanying this, it is probable that an absorption of oxygen corresponding to the equivalent of oxygen in the carbonic acid takes place. Experiments do not seem to have found the expired air from the lungs has lost more oxygen than the carbonic acid exhaled required, whence it follows that the supply of oxygen to form the carbonic acid transpired must be absorbed concomitantly. If now it be accepted that air containing the proportion of carbonic acid existing in expired breath is utterly spent for the purpose of breathing over again, and if an allowance of air for transpiration be made, it is established that each person in still life requires 580 to 600 cubic inches, or from 0·33 to 0·35 of a cubic foot of fresh air each minute, for perfect ventilation. Even this quantity can be reduced, as it is well known that in diving-bells men do live, and do continue to work, when the proportion of carbonic acid in the air of the bell rises to 8 per cent, instead of 4 per cent as it is found in once-exhaled air. Carbonic acid is an innocuous gas, quite harmless to animal life, except when it is substituted for oxygen in the air for breathing, and except also, in so far as its presence in large proportions interferes with the natural secretions from the lungs, and possibly from the skin.

Besides the carbonic acid, as one of the vitiations of exhaled air, there is known to exist a large proportion of aqueous vapour in the exhaled breath. Only $1\frac{7}{10}$ per cent in volume of the air inhaled at 70 degrees is vapour, while 5 per cent of the same volume is exhaled at 20 degrees higher temperature. (By weight the quantity of vapour will have been increased as 35 to 100.) To this excess of exhaled vapour derived from the lungs or fauces, there is to be added a large, but very variable, quantity of moisture imparted to the air of a room by insensible perspiration from the skin. The natural internal warmth of the body is very nearly 100° F., regardless of the heat of the external air, and comfort and health; even existence as a living animal depends upon the abstraction of heat from the surface of the body, so that the heat generated in the vital functions shall not elevate that internal temperature sensibly for any considerable length of time.

This part of my argument was more fully discussed in the paper "On the Relation of Moisture in Air to Health and Comfort," which was read by me before the American Institute of Architects at their meeting at Boston, in 1877. It was therein stated—"There are three means provided for the healthful dispersion of animal heat. The first is radiation to surrounding colder objects; the second, conduction to the atmosphere, which, for comfort, must be sensibly cooler than the body; and the third is evaporation from the moist surfaces of the lungs and throat, and evaporation from the roots of the pores of the skin. The first of these means—to the clothed person, at least—is comparatively ineffective; while the relative quantities of heat which may be eliminated in any given time or locality, by the last two, will probably be found nearly equal, in an atmosphere of about 70 degrees temperature, and of 65 to 70 per cent humidity."

It may be assumed, as the conclusion from data established by many experiments and observations, that 1·5 to 2·5 pounds of water are evaporated each day from a person in still life, or from one not taking violent exercise, or exposed to heat varying essentially from 70° F. This quantity of 2 pounds gives, under the conditions previously accepted, about three and a half times as much vapour evaporated by insensible perspiration as would be evaporated by breathing. If it be supposed that the moisture from insensible perspiration is to be absorbed and taken up by air of 70 degrees and of 70 per cent humidity, so that this air shall become saturated with humidity, it then follows that no less than 4 cubic feet of air must be supplied for this purpose to each person per minute.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, May 28th, 1881.

Professor FULLER in the Chair.

Mr. C. WOODWARD exhibited apparatus for illustrating wave motions to a class. This consisted of a number of glass panes of equal size mounted on stands so that they could be ranged in a line or in rank and file. Patches of blue paper were attached to them to represent the moving particle of the wave, the positions being determined by a diagrammatic card which fitted each pane. A machine for showing Fresnel's conception of polarised light consisted of two axles fitted with a number of cranks, which

supported a roof of rafters, bearing at their ridges a number of beads to guide the eye in tracing the wave motion. By turning the axles, the cranks shifted the frame of rafters, and the beads displayed the wave motion, which was vertical, elliptical, or circular, according to the adjustment.

Prof. G. Forbes explained the experiments made by him and Dr. Young to determine the velocity of light. The method employed was that of Fizeau, but instead of having one distant reflector and observing the total eclipse of the reflected ray by a tooth of the revolving wheel, two reflectors, one quarter mile behind the other, were used, and two rays, which were observed when of equal brightness. This method was found more accurate than Fizeau's own plan, and gave curves of brightness. The speeds of the toothed wheel were adjusted until the two rays appeared of equal brightness. The general result was that the velocity of the light of an electric lamp is 187,200 miles per second. Cornu found the light of a petroleum lamp to be 186,700 miles per second, and Michælson that of the sun to be 186,500 miles per second. The higher number of Prof. Forbes is probably due to the bluer light of electricity, for further experiments made with coloured lights and the spectrum, seemed to prove that the blue light travels probably over 1 per cent faster than red light. The experiments were made at Wemyss Bay, in Scotland.

Mr. Spottiswoode, P.R.S., said he had followed Prof. Forbes with interest, and these results appeared to modify our ideas of the luminiferous ether.

Lord Rayleigh enquired why it was that Jupiter's satellites showed no difference in tint in emerging from eclipse if red and blue rays travelled with unequal velocities, and

Prof. Forbes believed it due to the gradual character of the emergence of the satellites from behind their primary; according to the new theory variable stars should, however, be bluish with an increase of their light.

Prof. G. C. Foster pointed out that dispersion of the light in the air would rather have had the effect of retarding the blue rays.

Mr. Hall, of Baltimore, U.S., then exhibited the experiment in which a current of electricity flowing longitudinally along a thin foil of metal is caused to yield a transverse or lateral current by inserting the foil between the poles of a magnet. The lateral current is observed on a sensitive galvanometer, and care is taken in the first place to find points of connection with the foil, which yield no current before the magnet is applied. The results were that if iron is called +, the series is—iron +, silver −, gold −, platinum −, tin −. Curiously, nickel, though a magnetic metal, like iron, is −; but on enquiry of Prof. Chandler Roberts, it proved that the nickel employed was perhaps impure. Cobalt ranges between iron and silver and is +, like iron.

Prof. Perry suggested that the displacement and huddling of the lines of flow of the current by the magnet might cause the current, but

Mr. Hall said that an experiment had been tried to test that, and went to prove that it was not due to crowding of these lines.

The Secretary read a paper by Prof. J. H. Poynting "*On the Change of Bodies from the Solid to the Liquid State.*" There are two types of change, exemplified by ice-water and by sealing wax; in the one a surface melting at the same temperature, in the other a softening of mass and heating. The first was thought by Prof. Forbes to be a limiting case of the second type; but the author gives reasons for supposing that it is rather an exchange phenomenon, analogous to what takes place when water evaporates, and the melting-point is reached when the number of molecules passing from the ice to the water is equal to the number passing from the water to the ice. The sealing wax type is analogous to the change of state in a liquid-gas above its critical point, where it changes gradually from a rather liquid to a certainly gaseous state.

NOTICES OF BOOKS.

Manual of Organic Qualitative Analysis. (Lehrbuch der Organischen Qualitativen Analyse.) By Prof. Chr. Th. Barfoed. Kopenhagen: A. F. Höst and Son.

We have here the third and concluding part of Prof. Barfoed's useful treatise. It treats of the alkaloids and the vegetable colouring matters, and gives finally general directions for the examination of bodies containing organic ingredients. The thoroughness and excellence of the work makes us regret the more that the author has confined himself within such narrow boundaries. Thus among the organic bases we find mention merely of morphine, narcotine, strychnine, brucine, quinine, cinchonine, and veratrine. It may surely be said that caffeine, nicotine, and atropine are of sufficient importance to be dealt with in a work like that before us, not to speak of the artificial bases, which now play so important a part in the arts, and from the large scale upon which they are produced, and their varied applications, may often have to be sought for and identified by the analytical chemist.

Among the vegetable colouring matters we find mention only of indigotine, the blue principle of litmus, turmeric yellow, alkanet red, hematoxyline, brasileine, and the red of annatto. Chlorophyll, morine, carthamine, &c., are wanting, as well as colours of animal origin such as carminic acid.

Whilst regretting, however, what we cannot help feeling as a deficiency, we gladly bear testimony to the satisfactory character of the author's method within the limits which he has thought proper to select.

The History of Salt: with Observations on its Geographical Distribution, Geological Formation, and Medicinal and Dietetic Properties. By Evan Marlett Boddy, F.R.C.S., F.S.S. London: Baillière, Tindall, and Cox.

We have here a curious and interesting monograph. Its origin is perhaps due to the strange fact that the dietetic use of salt is now condemned and denounced by certain "persons" devoid of medical, and indeed of scientific, knowledge *in toto*, but well aware that the easiest way to become a "man of the time" is to raise an outcry against some ancient and established custom. One of these worthies has declared salt to be the "forbidden fruit" of the Mosaic record. Whether the anti-salt movement will, like vegetarianism, the anti-vivisection outcry, or the opposition to vaccination, assume a malignant type and break out into an agitation is uncertain. But we think that Dr. Boddy has done well by showing the many benefits due to the use of this general condiment, relished as it is, not by man alone, but by many of the lower animals. The mischief arising from the prolonged or exclusive use of salted provisions, to which the author refers, is evidently not due to the presence of salt in the food, but to the absence of certain necessary constituents which are eliminated in the salting process. Consequently this fact furnishes no argument against the use of salt along with our diet. Nor must it be forgotten, as the author points out, that the beef and pork salted for consumption at sea is often of very bad quality, and that the quantity of salt is so great as to rank as an adulterant rather than as an antiseptic.

On a few points we can scarcely agree with Mr. Boddy. Thus we find him writing—"When the chemist wishes to decompose water—or, in other words, to liberate hydrogen from oxygen—he has no better agent to effect the purpose than this greenish coloured gas (*i.e.*, chlorine), because it has such a strong affinity for hydrogen." Water can indeed, be decomposed by the action of chlorine, but the process is by no means convenient.

Elsewhere the writer speaks of common salt as being *adulterated* with sodium iodide. Considering the higher price of the latter, we may feel certain that it is never

intentionally added, though salt obtained from sea-water or from certain brine-springs might contain iodides as an impurity.

The account given of the salt-mine of Wieliczka, as we know from personal examination, is somewhat overdrawn. Vast as are the workings, the number of shafts is so great that the miners have no occasion to spend their lives underground.

In fine, the work before us, though brief in its compass, gives proof of wide and varied learning, and will be found pleasant and instructive reading, useful even to persons who have not embraced the anti-salt heresy.

Proceedings of the American Pharmaceutical Association at the Twenty-eighth Annual Meeting. 1880. Philadelphia: Sherman and Co.

A large part of this goodly volume consists of chemical and pharmaceutical notes extracted from the journals of the whole civilised world, and selected with care and judgment. Pharmaceutical nomenclature is the subject of a long paper. On one point we must disagree with the writer. He maintains that the names stibium, kalium, and natrium are used everywhere except in England and the United States. Now in France potassium and sodium are used just as in England, and even in Germany the term "soda" is more generally employed among technical chemists than "natron." The Presidential Address deals with a very important question of the day—the devastation of the forests and the consequent extinction of important medicinal plants. Surely it is time that all civilised governments should interfere with the random destruction of trees, and should prevent goats and swine from being turned out at large.

CORRESPONDENCE.

BAROMETER PUMPS.

To the Editor of the Chemical News.

Sir,—I have just seen that a correspondence has taken place in your journal about Mr. Sprengel's claim to be the first inventor of barometer pumps. This claim I dispute. I obtained a patent in May, 1847, for improvements in sugar refining, one of which is the conversion of a vacuum pan into a large barometer by placing under a common vacuum pan a long pipe in a perpendicular position, which acts as a pump whereby the sugar is taken out of the pan by its own weight in the long pipe, and thereby the vacuum in the pan is not destroyed, and the process of sugar-boiling is carried on continuously. The syrup to be boiled is added in a special evaporator at the upper part of the pan, while the boiled sugar is taken out at the bottom of the pan through the barometer pump. The specification of my patent was published in patent journals in London in 1847, and it is possible that Mr. Sprengel took the idea of his mercury barometer pump from my sugar barometer pump. But at all events Mr. Sprengel was not the first inventor of a barometer pump. I claim that honour.

Herewith you have a copy of the specification of my patent as published in 1847, with an engraving of the barometer pump.—I am, &c.,

James Johnstone.

Experiment Rooms, 1, James Square,
Edinburgh, May 27, 1881.

[Mr. William Johnstone made the same claim in the Chemical News for July 25, 1879, and after careful examination we appended to his letter the following note:—"The quotations which Mr. Johnstone gives from his father's specification show that the 'Johnstone barometer pump' is an entirely different instrument from the Sprengel pump.'"—*Ed.* C.N.]

THE SO-CALLED "BUNSEN" PUMP.

To the Editor of the Chemical News.

Sir,—As a rule I do not think it advisable to take notice of anonymous communications, but let me assume "Verax" (Chemical News, vol. xliii., p. 231) to be a gentleman whose opinion deserves all consideration.

Hence I beg to say, in reply, that I am not aware of having published anything which could lead "Verax" to say that I had confessed my water-air-pump to be a comparative failure, and that I laid it aside as a non-success. My words (*Journ. Chem. Soc.*, 1865, p. 17) are "*that it* (the water-air-pump) *would furnish a simple and most efficient exhausting machine.*" It should not be necessary to mention that such an exhausting machine, however simple and efficient, is as little a filtering apparatus as a Bunsen burner is a distilling apparatus or a spectroscope.

As I have not published anything about the applications of my air-pumps—be they worked with oil, or water, or sulphuric acid, or mercury, or mixtures of liquids and solids—it appears that on this account "Verax," Prof. Roscoe, and others, do not consider me the legitimate inventor of these instruments. True, I am admitted to be the owner of the "*principle*," but still this poor principle is placed behind the application, apparently to illustrate that the horse is moved by the cart. In our utilitarian age one is expected not only to build a ship on a new principle, but to sail her as well and discover an America. This is hardly fair to the ship-builder.

Supposing my water-air-pump should be applied in future with great success by somebody who is not Prof. Bunsen (say "Verax") to something of great importance, which is not filtering, would it not be a misnomer to call this new and ingenious application, or adaptation, or *annexation*—or whatever else it may be—a "Bunsen's filter pump," being *ipso facto* a legitimate "Verax's —— pump," according to Verax's own showing?

But why should I resort to the future, if the past furnishes such ample proofs for my argument? Why do these advocates of application not speak of a "Graham's extraction and transfer pump"? Of a "Crookes's radiometer pump"? Of a "Frankland and Armstrong's combustion pump"? Of an "Edison and Swan's electric light pump"? and so forth. Surely these appliers of my pump deserve to be remembered in connection with it as much as Prof. Bunsen, *particularly the late Mr. Graham, who did more for this instrument than anyone since its invention.* Such is my opinion.

The hastening of filtration is only one instance of the many applications to which my instruments have been put, and most likely will be put as long as an atmosphere surrounds the earth. Hence the names "Bunsen pump" and "filter pump" are both *misnomers* for the reasons which I have given, or rather have been forced to give, not through "*susceptibilities*" of my own, but through the persistent misrepresentation of the facts by Prof. Bunsen's over-zealous friends.—I am, &c.,

H. Sprengel.

London, Savile Club, May 26, 1881.

THE ESTIMATION OF PHOSPHORUS IN STEEL.

To the Editor of the Chemical News.

Sir,—I am glad that "Phosphorus" has done me the justice to acknowledge that he "misconstrued" my results, though I regret that he has not withdrawn in a more graceful manner statements that strained the courtesies of scientific debate.

The issue which "Phosphorus" raised in his first letter as to the conversion of the pyro- into ortho-phosphate, and which made "the value of the results very slight," he is now "not prepared to deny," although he has "doubts." Now, Sir, if "*arguments*" do not depend for their cogency on the identity of their employer, when "*doubts*" are arrayed against the results of actual experiment, the

identity of the employer of the "doubts" becomes a factor of some moment. If "Phosphorus" will make a series of experiments on pure $Mg_2P_2O_7$, and test the question practically, I think his doubts will vanish.

"Phosphorus" intimates that the last paragraph of my letter was based on a misconstruction of *his* last paragraph, which he now says referred to my *first* experiments. In obedience to his request I have re-read his letter, and find these words:—"Conversely by his suggested modified plans he would re-dissolve 234·9 m.grms. of yellow precipitate in order to convert it into 13·9 m.grms. of magnesium pyro-phosphate! And this is done for the purpose of getting a more accurate result!" But as the "suggested modified plans" were the *last* experiments, I cannot quite see how to reconcile the two statements.

I must thank "Phosphorus" for having defined his position, as I must confess I was a little hazy as to what his views really were. Knowing them to some extent now I shall demonstrate to "Phosphorus" that his standpoint is a most untenable one. He makes the assertion that rapidity is only a secondary consideration in an estimation of phosphorus. Well, Sir, any one acquainted with the routine of a busy steel works will be able to form an estimate of the value of this statement. Admitting that the results obtained by a careful molybdate estimation are accurate enough for practical purposes, but that by the modified process results can be obtained *more quickly and more accurately*, which process is to be preferred? The question is not which method gives the heavier precipitate, but which is the more accurate? Has "Phosphorus" any data to prove that the proposed method is not accurate? Certainly up to the present he has made no attempt in that direction, excepting the objection that the pyro-phosphate is soluble in the liquid from which it is precipitated. This would make the results *low*, whereas they always come higher than the molybdate; therefore if I am correct in interpreting this objection into an insinuation that the modified method is low, much more then will the molybdate be low.

As the issue between "Phosphorus" and myself seems to be now pretty clear, I hope he will abandon generalities, which are proverbially difficult to meet, and fight out the controversy on concrete data.—I am, &c.,

J. Oliver Arnold.

Sheffield, May 23, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 17, April 25, 1881.

Examination of Materials from the Vitrified Forts of Craig Phadrick, near Inverness, and of Harmannswillerkopf, in Haute Alsace.—M. Daubrée.—These materials furnish a new opportunity for remarking the wonderful facility with which crystalline mineral species may be formed in a vitreous mass suitably heated; they contribute to throw light on the theory of metamorphism.

Researches on Piperidine.—A. W. Hofmann.—The author describes dimethyl-piperyl-ammonium iodide, a new base, which he names provisionally dimethyl-piperidine; trimethyl-piperyl ammonium iodide, and piperylene, a carbide of the composition C_5H_8.

Essence of Licari Kanali.—H. Morin.—This essential oil is obtained from a tree of Cayenne, a species of *Acrodiclidium*. The oil boils at 198°; its sp. gr. is 0·868; its rotatory power is −19°. Its composition is expressed by the formula $C_{20}H_{18}O_2$. It appears to be an isomer of Borneo camphor.

A Nodule of Chromite in the Interior of Meteoric Iron from Cohahuila, Mexico.—Lawrence Smith.—The nodule in question was composed of chromic and ferrous oxides, with a little magnesia, cobalt, and silica.

Normal Production of the Three Systems of Fringes of Rectilineal Rays.—M. Crollebois.—A mathematical paper, not suitable for abridgment.

Disturbing Causes of Telephonic Transmissions.—M. Gaiffe.—Two rods of equal length having been cut from one and the same bar of steel capable of being strongly polarised without having been tempered, one of them was magnetised as strongly as possible, and they were then placed in a telephonic circuit. On striking them both in the same manner the author found that the magnetised bar gave energetic currents, whilst the other gave relatively but little. This fact seems to find a satisfactory explanation in the theory of Ampère.

Origin of Nephrozymase in the Kidneys.—MM. J. Béchamp and Baltus.—The authors prove that the albumenoid ferment, nephrozymase, exists in urine obtained by urethral fistulæ, that it is directly secreted by the kidneys, and that it exists in larger proportions before its arrival in the bladder than after its stay in that organ.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 8.

Compounds of Organic Bases with the Haloid Salts of Mercury.—Otto Klein.—The author has obtained and examined compounds of aniline and mercuric bromide, aniline and mercuric iodide, para-toluidine and mercuric bromide, para-toluidine and mercuric iodide, and the corresponding compounds of ortho-toluidine.

Di-oxy-benzo-phenon.—W. Staedel and E. Sauer.—The authors have obtained β-di-oxy-benzo-phenon, which is much more soluble in water than the α- compound, and crystallises in stellar groups of small white needles.

Iso-indol.—W. Staedel and Fr. Kleinschmidt.—The authors give C_8H_7N as the preferable formula for this compound.

Brom-nitro- and Brom-amido-anisols.—W. Staedel and G. Damm.—The authors describe mono-brom-para-nitro-anisol, mono-brom-para-anisidine, and di-brom-para-anisidine.

Vapour-Tensions of Halogen-Substituted Ethans.—W. Staedel.—The author lays down the generalisation that with the decreasing volatility of the liquid, the increase of tension for 1° becomes less.

A New Synthesis of Oxygenous Organic Bases.—W. Staedel and O. Siepermann.—This memoir does not admit of useful abstraction.

Action of Certain Metals and Non-Metals upon Phosphorus Oxychloride, and the Existence of Leverrier's Phosphorus Oxide.—B. Reinitzer and H. Goldschmidt.—In the more usual case the molecule of phosphorus oxychloride is deprived of its oxygen with formation of phosphorus trichloride. In rarer cases all the three atoms of chlorine pass to the metal, phosphorus oxide, P_4O, being formed.

Vapour-Density of Iodine.—Fr. Meier and J. M. Crafts.—This long and important paper cannot be intelligibly reproduced without the accompanying figures. From their experiments the authors conclude that the density of iodine becomes abnormal between 600° and 700°, and decreases progressively with the rising temperature, until at about 1390° it becomes 0·60 of the theoretical amount. We conjecture that this diminution would continue, and at higher temperatures would reach the proportion of 0·5. If this abnormal density is due to dissociation we assume that the molecule I_2 is gradually resolved into I+I, or that the group representing a physical unit is split into two parts, and we do not believe that a new hypothesis on the constitution of iodine can be founded on the above results.

Brom-carbon Oxide.—A. Emmerling.—The author's researches have not been completed. The compound obtained is a heavy colourless liquid, of the same penetrating suffocating odour as that of chlor-carbon oxide. The vapours have the property of causing vulcanised india-rubber to swell in a remarkable degree.

Behaviour of Antimony Penta-chloride with Phosphorus Trichloride.—H. Kœhler.—The compound obtained is phosphor-antimony deca-chloride.

Action of Zinc upon Succinimide.—Chichester A. Bell.—The chief product of the decomposition is pyrrol, mixed with other basic substances.

Probable Occurrence of Furfuran and a Homologue among the Products of the Destructive Distillation of Pine Wood.—A. Atterberg.—The homologue of furfuran thus obtained is named by the author sylvan, $C_4H_3O.CH_3$, and forms a member of a little-known group of compounds deducible from furfuran (tetra-phenol), and including furfuran, sylvan, furfurol, fucusol, pyro-mucic, and pyro-comonic acids, comenic, pyro-meconic, and dehydro-mucic acids, and meconic acid.

A Modification of Zulkowsky's Apparatus for the Volumetric Determination of Nitrogen.—E. Ludwig.

Determination of Nitrogen.—Hugo Schiff.—These two papers cannot be reproduced without the accompanying illustrations.

On α-Di-dinitro-phenyl-ether.—C. Willgerodt.—This ether when pure is colourless, melting at 195°, and separates from most of its solvents in short thick crystals. It is plentifully soluble in glacial acetic acid, benzol, chloroform, and amylic alcohol.

Abietic Acid.—W. Kelbe.—Abietic acid, $C_{44}H_{64}O_5$, is obtained from that portion of crude resin-oil which is dissolved by caustic soda. The author gives an extended account of its properties.

Nitro-benzoic Acid.—A. Claus.—A memoir written to controvert the view of Fittica (*Berichte*, 13, 711) that there exist more than three mono-nitro-benzoic acids.

Cymols.—A. Claus.—A description of ortho-cymol, meta-cymol, and the behaviour of para-cymol with sulphuric acid.

Certain Derivatives of Iso-butyl-aldehyd.—A. Lipp.—Not adapted for useful abstraction.

Synthesis of Chinoline—W. Kœnigs.—Chinoline is obtained by the action of glycerin and sulphuric acid upon a mixture of nitro-benzol and aniline.

Fluorescence in the Anthracen Series.—C. Liebermann.—The author gives very extensive lists of the fluorescent and non-fluorescent bodies belonging to this series.

New Methods of Forming Diamines.—A. Bernthsen and F. Szymanski.—The authors show that diamines are formed by the reduction of amidines.

Ortho-anisidine.—O. Mühlhäuser.—Not suitable for abstraction.

Vol. 13, No. 9.

Determination of the Value of Zinc and Zinc-powder.—F. Beilstein and L. Jawein.—The apparatus used by the authors cannot be intelligibly described without the aid of the accompanying figure.

The Atomic Weight of Antimony: A Preliminary Communication.—Josiah P. Cooke.—The author's repeated and very carefully-conducted determinations yield a mean value of 120·01 for the atomic weight of this element.

The Combustion-Heat of Sulphur.—Julius Thomsen.—The author determines the combustion-heat of rhombic sulphur = 71,080 cals.; that of monoklinar sulphur = 71,720 cals., the transit from the latter to the former state being accompanied with a disengagement of 640 cals. As Favre and Silbermann found the combustion-heat of rhombic sulphur 71,040 cals., whilst M. Berthelot makes it only = 69,100 cals., the determination of the latter chemist is 2·7 per cent too low.

New Lactones.—R. Fittig.—The author describes three new lactones—that of normal capronic acid, that of normal valerianic acid, and one obtained on the dry distillation of terpenylic acid.

The Constitution of Liquid Chlorolactic Acid and Oxacrylic Acid.—P. Melikoff.—Not suitable for abstraction.

On β-Bromolactic Acid.—P. Melikoff.—This compound is obtained from oxyacrylic acid by the addition of hydrobromic acid.

A Word on O. Fischer's Memoir on Diamido-triphenyl-methan.—C. Böttinger.—A reply to O. Fischer's paper, *Berichte*, p. 665.

Constitution of the Products of the Action of Bromine and Nitric Acid upon Aromatic Amido-Compounds and upon the Six Isomeric Dibrom-toluols.—R. H. C. Nevile and A. Winther.

The Six Tri-brom-toluols, the Three Tetra-brom-toluols, and Penta-brom-toluol.—R. H. C. Nevile and A. Winther.—These two papers may be found in full in the *Journal of the Chemical Society*.

Kreatinoid Compounds of the Aromatic Group (No. III.).—Peter Griess.—The author describes ortho-benz-glyco-cyamidine, α-ortho-methyl-benz-glyco-cyamidine, and the corresponding β-compound.

Biebrich Scarlet.—W. v. Miller.—The author admits that the red tinctorial principles of this dye are really sulphacids of a complex azo-compound.

Decomposition of Simple Organic Compounds by Zinc Powder.—Hans Jahn.—Methyl-alcohol is completely resolved by zinc powder into carbonic oxide and hydrogen. Ethyl-alcohol yields hydrogen, carbonic oxide, and light carburetted hydrogen.

Victor Meyer's Determination of Vapour-Density—Lothar Meyer.—The author figures an arrangement for avoiding a source of error of which V. Meyer complains (*Berichte*, pp. 813 and 814).

Guanidine-like Compounds.—F. Berger.—The author describes a compound which he has obtained, $C_9H_{11}N_3O_2$, and which he names glycolyl-mono-phenyl-guanidine.

Reply to H. Kolbe and E. v. Meyer.—W. Hempel.—A lengthy polemical paper in reference to the *Journal für Praktische Chemie*, vol. 21, No. 9.

Quantitative Determination of Aceton in Methylic Alcohol.—C. Krämer, after criticising previous methods for the quantitative and qualitative examination of methyl-alcohol, proposes an improved process. The requisites are some graduated pipettes, a mixing cylinder holding 50 c.c., a tared watch-glass, and the following reagents: Double normal solutions of iodine and of soda, and ether free from alcohol. Into the mixing cylinder are poured 10 c.c. of the soda solution, then 1 c.c. of the sample in question, and, after well shaking, 5 c.c. of the iodine solution, the shaking being repeated. The iodoform which separates in flocks is dissolved by the addition of 10 c.c. of ether. After standing for a short time a stratum of ether floats above the solution of sodium iodide, and amounts to about 9·5 c.c. An aliquot part of this (5 c.c.) is drawn off with a pipette and evaporated in the tared watch-glass. After the escape of the ether the glass is dried for a short time over sulphuric acid and weighed. The increase of weight shows the iodoform, which is easily calculated into aceton. 1 mol. aceton = 58 + 6 iodine = 127 × 6 gives 1 mol. iodoform = 394, of which we have $\frac{9·5}{5}$ on the watch-glass. The weight obtained is therefore multiplied by $\frac{58·9·5}{394·5} = 0·28$ approximately to find the aceton in a c.c. of the alcohol.

Influence of the Foreign Constituents of Wood Spirit upon the Methylation of Aniline.—G. Krämer and M. Grodzky.—Among these ingredients aceton is the most injurious, not merely decreasing the yield, but rendering the violet colours produced of an impure tone.

Communication on Iodine.—V. Meyer.—In a preliminary critique on the results of MM. Crafts and F. Meier, the author questions their view that a minimum is attained at 4·39 (I_1), and hopes to prove that the end of the dissociation will be reached at $\frac{1}{3}I_2$ (2·93).

Aromatic Amido-ketons.—Oscar Dœbner.—A description of the behaviour of benzoyl-chloride with phthalanil, and of benzo-aniline.

Roofing Copper.—Alex. Muller.—The author ascertains the relative power of samples of sheet copper to resist corrosion by exposure to the vapours of hydrochloric acid.

Vol. 13, No. 10.

Knowledge of the Camphor Chlorides.—F. v. Spitzer.—The author concludes that the bodies described by Pfaundler as camphor dichloride, melting at 70°, and mono-chloride, melting at 60°, are merely mixtures.

Behaviour of Succinimide with Phosphorus Pentachloride and with Zinc Powder.—A. Bernthsen.—A preliminary communication which the author makes to secure his right to continue his researches on the subject.

Progress of Dissociation in the Vapour of Iodine.—Alex. Naumann.—The author gives a table of the densities, degrees of decomposition, and progress of dissociation of the vapour of iodine. He holds that the progress of dissociation which appears in this table harmonises with the general law deduced from the mechanical gas-theory respecting the progress of dissociation with a rising temperature, according to which "the increments of decomposition corresponding to equal differences of temperature increase constantly from the temperature of commencing dissociation till it is half completed, and decrease in a similar manner until the temperature of the completion of dissociation"—a law confirmed experimentally by the investigation of the progress of the dissociation of the vapours of other bodies, especially of hyponitric acid (*Ann. Chem. Pharm.*, 1868, suppl., 6, 205, and Alex. Naumann's "Allgemeine and Physikalische Chemie," p. 240). In the decomposition of the vapour of iodine there is a great range of temperature of the dissociation. The process begins at about 600°, and at 1270° it is half completed. May we assume that the completion of the process lies higher by a number of degrees equal to the difference?

Chole-camphoric Acid and its Relation to Cholanic Acid.—P. Latschinoff.—Chole-camphoric acid under a variety of circumstances loses the elements of water, and passes into cholanic acid. The inverse process is still more easy.

Remarks on the Papers of MM. von Miller and on Biebrich Scarlet.—Leo Vignan and J. Boas Boasson.—In the *Berichte*, 13, p. 543, Von Miller describes "Biebrich Scarlet" as having been introduced into commerce by Kalle and Co., and as having been for some time manufactured by the Berlin "Actien Gesellschaft für Anilin Fabrikation." On p. 800 Nietzki claims the priority of the discovery for Kalle and Co., and for himself. The firm of Henriet Komann and Vignan, colour makers of Lyon, deposited with the Conseil des Prudhommes an account of the preparation of these colours as far back as Aug. 22, 1878, more than a year before the date of the patent of Græssler (Jan. 29, 1880, and Krügerer, Nov. 27, 1879), and six months before the Biebrich scarlet was introduced into trade. The document thus deposited runs: "We wish to secure for ourselves the priority of the discovery of the colouring-matters produced by the action of the phenols, amines, and their sulphacids upon the diazo-compounds of amido-azo-benzol, amido-azo-toluol, and amido-azo-naphthaline. The colours can be advantageously substituted for the vegetable dyes. The accompanying sample is obtained by the action of sulphonaphtholic acid upon diazoised amido-azo-benzol, and yields upon silk and wool shades resembling those produced by orchil."

Constitution of the Reduction-Product of Succinyl-chloride.—A. Saytzeff.—The author obtains this substance by the fractional distillation of oxy-butyric acid. The reduction-product is not an aldehyd, but the anhydride of normal oxy-butyric acid, and belongs in the series of Fittig's lactones.

Xanthogenic Acid, a Precipitant of the Albuminoids.—P. Zöller.—Potassium xanthogenate added to acidulated solutions of the various modifications of albumen produces a flocculent precipitate.

Globulinoid Substances in Potato Tubers.—P. Zöller.—The author confirms the presence of these substances in the potato, and describes a method for their isolation.

Formation of Hydrogen Peroxide and Ozone on the Action of Moist Phosphorus upon Air.—Albert R. Leeds.—Already inserted.

New Measurements of the Densities of Solid Organic Compounds (Series III.).—H. Schrœder.—This important paper does not admit of abridgment.

Amido-lactic Acids of Different Origin.—E. Erlenmeyer.—Not adapted for useful abstraction.

Determination of Vapour-Densities.—J. Piccard.—The author describes and figures a modification of the apparatus used by his colleague V. Meyer.

Tropeines.—A. Ladenburg.—The compounds here described are oxy-benzoyl-tropeine, para-oxy-benzoyl-tropeine, ortho-oxy-benzoyl-tropeine, benzoyl-tropeine, phthalyl-tropeine, atropyl-tropeine, cinnamyl-tropeine, and oxy-toluyl-tropeine.

Derivatives of the Toluidines.—J. Cosack.—An account of ortho-tolyl-urea, meta-tolyl-urea, meta-tolyl-urethan, para- and ortho-tolyl-glycocoll, meta-ditolyl-amine, nitroso-para-ditolyl-amine, and aceto-meta-ditolyl-amine.

Separation of Hippuric and Benzoic Acid in Fever.—T. Weyl and B. von Anrep.—A normal rabbit fed on milk and oats excretes hippuric acid and generally also free benzoic acid. During fever it excretes more free benzoic acid and less hippuric acid. A normal dog fed on meat and bacon excretes always hippuric acid, and generally small quantities of free benzoic acid. During fever the excretion of the former acid decreases.

Thermic Formation of the Oxides of Nitrogen.—Julius Thomsen.—The author points out that the determinations published by M. Berthelot (*Comptes Rendus*, 90, 779) agree most closely with his own, published at an earlier date, the only exception being in the case of nitrous oxide. Still the French chemist pronounces the author's method as wanting in a guaranteed basis.

A further Simplification of the Process of Dumas for the Determination of Nitrogen.—Karl Zulkowsky.—This important paper requires the accompanying illustration.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Royal Institution. General Monthly Meeting, 5.
TUESDAY, 7th.—Royal Institution, 3 p.m. "Thomas Carlyle," Prof. H. Morley.
WEDNESDAY, 8th.—Microscopical, 8.
—— Geological, 8.
THURSDAY, 9.—Royal Institution, 3. "Russian Litterature: Tourgenieff," Prof. C. E. Turner.
—— Mathematical, 8.
FRIDAY, 10th.—Royal Institution, 8. "Origin and Identity of Spectra," Prof. Dewar, 9.
—— Quekett, 8.
SATURDAY, 11th.—Royal Institution, 3. "Russian Literature: Nekrasoff," Prof. C. E. Turner.
SATURDAY, 12th.—Physical, 3. "The Hardening of Steel," Prof. W Chandler Roberts, F.R.S. "Curves of Electro-magnetic Induction," W. Grant.

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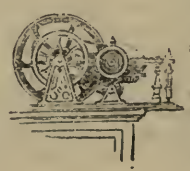

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THE CHEMICAL NEWS.

VOL. XLIII. No. 1124.

ON THE

SPECTRUM OF MAGNESIUM UNDER VARIOUS CIRCUMSTANCES.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

SINCE our last communication on this subject (*Proc. Roy. Soc.*, 1880, No. 200), several authors—Ciamician, Cornu, Fievez, and Lockyer—have published observations on the spectrum of magnesium, to some of which allusion is made in the sequel, but these observations by no means exhaust the subject. Our own observations, carried on for a considerable time, have extended to new regions and a variety of circumstances, and the summary of them which we now present to the Society will, we hope, help to bring out the connexion between some of the variations in the spectrum of this element and the conditions under which it is observed, and to throw additional light on the question of the emissive power for radiation of short wave-lengths of substances at the temperature of flames to which we alluded in our paper on the spectrum of water (*Proc. Roy. Soc.*, 1880, No. 201).

We begin with an account of these observations.

Spectrum of the Flame of Burning Magnesium.

When magnesium wire or ribbon is burnt in air, we see the three lines of the *b* group, the blue line about wave-length 4570, first noticed by us in the spark spectrum (*Proc. Roy. Soc.*, vol. 27, p. 350); and photographs show, besides, the well-known triplet in the ultra-violet between the solar lines K and L sharply defined, and the line for which Cornu has found the wave-length 2850 very much expanded and strongly reversed. These lines are all common to the flame, arc, and spark spectra; and the last of them (2850) seems to be by far the strongest line both in the flame and arc, and is one of the strongest in the spark. But, in addition to these lines, the photographs of the flame show a very strong, somewhat diffuse, triplet, generally resembling the other magnesium triplets in the relative position of its components, close to the solar line M; and a group of bands below it extending beyond the triplet near L. These bands have, for the most part, each one sharply defined edge, but fade away on the other side; but the diffuse edges are not all turned towards the same side of the spectrum. (The positions of the sharp edges of these bands, and of the strong triplet near M, were shown in a figure.) It is remarkable that the triplets near P and S are absent from the flame spectrum, and that the strong triplet near M is not represented at all either in the arc or spark. The hydrogen-magnesium series of lines, beginning at a wave-length about 5210, are also seen sometimes, as already described by us (*Proc. Roy. Soc.*, vol. 30, p. 96), in the spectrum of the flame; but we have never observed that the appearance of these lines, or of the strong line with which they begin, is connected with the non appearance of b_4. Indeed, we can almost always see all three lines of the *b* group in the flame, though as b_4 is the least strong of the three, it is likely to be most easily overpowered by the continuous spectrum of the flame. The new observations recorded below leave, we think, no room for doubt that the series of lines beginning at wave length 5210 are due to a combination of hydrogen with magnesium, and are not dependent solely on the temperature.

The wave-lengths of the strong triplet near M are about 3720, 3724, 3730, and of the defined edges of the bands about 3750, 3756, 3765, 3772, 3777, 3782, 3790, 3799, 3806, 3810, 3815, 3824, 3841, 3845, 3848, 3855, 3858, 3860, 3865.

Burning magnesium in oxygen instead of atmospheric air does not bring out any additional lines; on the contrary, the continuous spectrum from the magnesia formed overpowers the line spectrum, and makes it more difficult of observation.

Magnesia heated in the oxyhydrogen jet does not appear to give the lines seen in the flame.

We have left out of the figure and from the enumeration of lines the well-known bands of the oxide.

Spectrum of the Arc.

By examining the arc of a battery of 40 Grove's cells, or that of a Siemens machine, taken in a crucible of dense magnesia under the dispersion of the spectrum of the fourth order, given by a Rutherford grating of 17,296 lines to the inch, we are able to separate the iron and magnesium lines which form the very close pair b_4 of the solar spectrum. Either of the two lines can be rendered the more prominent of the pair at will, by introducing iron or magnesium into the crucible. The less refrangible line of the pair is thus seen to be due to iron, the more refrangible to magnesium. Comparison of the solar line and the spark between magnesium points confirms this conclusion, that the magnesium line is the more refrangible of the two.

In the ultra-violet part of the spectrum photographs show several new lines. First, a pair of lines above U at wave-lengths about 2942, 2938·5. These lines are a little below a pair of lines given by the spark for which Cornu has found the wave-lengths 2934·9, 2926·7. The latter pair are not seen at all in photographs of the arc, nor the former in those of the spark. The strong line, wave-length about 2850, is always seen, very frequently reversed. Of the quadruple group in the spark to which Cornu has assigned the wave-lengths 2801·3, 2797·1, 2794·5, and 2789·9, the first and third are strongly developed in the arc, the other two not at all. Next follows a set of five nearly equidistant lines, well-defined and strong, but much less strong than the two previously mentioned, wave-lengths about 2782·2, 2780·7, 2779·5, 2778·2, 2776·9. The middle line is a little stronger than the others. The same lines come out in the spark.

Beyond these follow a series of pairs and triplets; probably they are triplets in every case; but the third, most refrangible, line of the triplets is the weakest, and has not in every case been noticed as yet. These succeed one another at decreasing intervals with diminishing strength, and are alternately sharp and diffuse, the diffuse triplets being the strongest. The series resembles in general character the sodium and the potassium series described by us in a former communication, and we cannot resist the inference that they must be harmonically related, though they do not follow a simple harmonic law. The most refrangible line in the figure at wave-length 2605 represents a faint diffused band which is not resolvable into lines; it belongs, no doubt, to the diffused members of the series, and, to complete the series, there should be another sharp group between it and the line at wave-length 2630. This belonging to the weaker members of the series is too weak to be seen.

The approximate wave-lengths found by us for these lines are as follows:—2767·5, 2764·5, 2736, 2732·5, 2731, 2698, 2695, 2693·5, 2672·5, 2670, 2668·5, 2649, 2646, 2633, 2630, 2605.

It is worthy of remark that the line at wave-length 5710, described by us in a previous comunication (*Proc. Roy. Soc.*, No. 200, p. 98), is very nearly the octave of the strong line at 2850. Moreover, the measures we have taken of the wave-length of this last line, with a Rutherford grating of 17,296 lines to the inch, indicate a wave-length 2852 nearly, which is still closer to the half of 5710.

* A Paper read before the Royal Society, May 12, 1881.

In Cornu's map of the solar spectrum a line is ascribed to magnesium with the wave-length 3278. Although a line at this place appears in many of our photograghs of the arc, we have not been able to identify it as a line due to magnesium. It does not show any increased strength when magnesium is introduced into the arc. When metallic magnesium is dropped into a crucible of magnesia or lime through which the arc is passing, the electric current seems sometimes to be conducted chiefly or entirely by the vapourised metal, so that the lines of other metals almost or wholly disappear; but the line at wave-length 3278 does not in such cases appear, though the other magnesium lines are very strongly developed. The line at wave-length 2850 is often, under such circumstances, enormously expanded and reversed, those at wave-lengths 2801, 2794, and the alternate diffused triplets, including those near L and near S, much expanded and reversed, and the group of five lines (2776—2782) sometimes reversed.

When the arc of a Siemens machine is taken in a magnesia crucible, the strong line of the flame spectrum, wave-length 4570, is well seen sharply defined; it comes out strongly and a little expanded on dropping in a fragment of magnesium. When a gentle stream of hydrogen is led in through a hollow pole, this line is frequently reversed as a sharp black line on a continuous background. From comparing the position of this line with those of the titanium lines in its neighbourhood, produced by putting some titanic oxide into the crucible, we have little doubt that it is identical with the solar line 4570·9 of Ångström.

When the arc is taken in a crucible into which the air has access, it may be assumed that the atmosphere about the arc is a mixture of nitrogen and carbonic oxide. When a stream of hydrogen is passed, either through a perforated pole or by a separate opening, into the crucible, the general effect is to shorten the length to which the arc can be drawn out, increase the relative intensity of the continuous spectrum, and diminish the intensity of the metallic lines. Thus, with a very gentle stream of hydrogen in a magnesia crucible, most of the metallic lines, except the strongest and those of magnesium, disappear.

Those lines which remain are sometimes reversed; those at wave-length 2850 and the triplet near L being always so. With a stronger stream the lines of magnesium also disappear, the *b* triplet being the last in that neighbourhood to go, and b_1 and b_2 remaining after b_4 had disappeared.

Chlorine seems to have an opposite effect to hydrogen, generally intensifying the metallic lines, at least those of the less volatile metals, but it does not sensibly affect the spectrum of magnesium. Nitrous oxide produces no marked effect; coal-gas acts much as hydrogen.

Spectrum of the Spark.

In the spark of an induction coil taken between magnesium points in air we get all the lines seen in the arc except two blue lines at wave-lengths 4350 and 4166, two lines above U, and the series of triplets more refrangible than the quintuple group about wave-length 2780. The blue line wave-length about 4570 is best seen in the spark without a jar when the magnesium electrodes are close together, and the rheotome made to work slowly; and this and the other faint lines of the spark at about 4586 and 4808 require for their detection a spectroscope in which the loss of light is small.

On the other hand, some additional lines are seen. Of these, the strong line at wave-length 4481 and the weaker line at 4586 are well known. Another faint line in the blue at wave-length 4808* has been observed by us in the spark, and two diffuse pairs between H and the triplet near L. Two ultra-violet lines at wave-lengths 2934·9, 2926·7 (Cornu) are near, but not identical with, two lines of the arc above mentioned; and two more lines at wave-lengths 2797·1, 2789·9 (Cornu) make a quadruple group with the very strong pair conspicuous in the arc in this region. The spectrum of the spark ends, so far as we have observed, with the quintuple group (2782—2776) already described in the arc.

When a Leyden jar is used with the coil, some of the lines are reversed. This is notably the case with the triplet near L, the line at wave-length 2850, and those at 2801 and 2794. Cornu (*Comptes Rendus*, 1871) noticed the reversal of the less refrangible two lines of the triplet near L under these circumstances. This effect is very much increased by increasing the pressure of the gas in which the spark is taken. For the purpose of observing the influence of increased pressures, we have used a Cailletet pump and glass tubes similar to those employed in the liquefaction of gases by means of such a pump, but with an expansion of the upper part in which were magnesium electrodes attached to platinum wires sealed into the glass. The tube having been filled with gas at the atmospheric pressure, was sealed at its upper end, while the lower end dipped into mercury contained in the iron bottle of the Cailletet pump, and the gas was afterwards compressed by driving more or less mercury into the tube. The gases used were hydrogen, nitrogen, and carbonic oxide; and the image of the spark was thrown on to the slit of the spectroscope by a lens. In hydrogen, when no Leyden jar was used, the brightness of the yellow and of the blue lines of magnesium, except at first that at wave-length 4570, diminished as the pressure increased; while, on the other hand, the *b* group was decidedly stronger at the higher pressure. The pressure was carried up to 20 atmospheres, and then the magnesium lines in the blue and below almost or entirely disappear, leaving only the *b* group very bright, and the magnesium-hydrogen bands which are described below; even the hydrogen lines F and C were not visible. When a jar was used, the magnesium lines expanded as the pressure was increased; all three lines of the *b* group were expanded and reversed at a pressure of 5 atmospheres; the yellow line, wave-length 5528, was also expanded but not reversed; and the line at 4481 became a broad, very diffuse band, but the line at wave-length 4570 was but very little expanded. The expansion both of the *b* group and of the yellow line seemed to be greater on the less refrangible than on the more refrangible side of each line, so that the black line in those which were reversed was not in the middle. When the jar was used the pressure could not be carried beyond 10 or 12½ atmospheres, as the resistance became then so great that the spark would not pass across the small distance of about 1 millim. between the electrodes. At a pressure of 2½ atmospheres, with a jar, the ultra-violet magnesium triplet near L was very well reversed, and the two pairs of lines on its less refrangible side were expanded into two diffuse bands.

In nitrogen and in carbonic oxide the general effects of increased pressure on the magnesium lines (not the magnesium-hydrogen bands) seemed to be much the same as in hydrogen. Without a jar the blue and yellow lines were enfeebled, and at the higher pressure disappeared, while the *b* group was very brilliant but not much expanded. With the jar all the lines were expanded, and all three lines of the *b* group strongly reversed. The bands of the oxide (wave-length 4930—5000) were not seen at all in hydrogen or nitrogen; they were seen at first in carbonic oxide, but not after the sparking had been continued for some time.

The disappearance of certain lines at increased pressure is in harmony with the observations of Cazin (*Phil. Mag.*, 1877, vol. iv., 154), who noticed that the banded spectrum of nitrogen, and also the lines, grew fainter as the pressure was increased, and finally disappeared. When a Leyden jar is employed there is a very great increase in the amount of matter volatilised by the spark from the electrodes, as is shown by the very rapid blackening of the sides of the tube with the deposited metal, and this increase of the

* This line we first noticed in a former communication (*Proc. Roy. Soc.*, vol. 27, p. 353), but the wave-length is there given, through an error in taking out the ordinate of the curve of interpolation, as 4797 instead of 4807. Another measure has given the wave-length 4808.

amount of metallic vapour may reasonably be supposed to affect the character of the discharge, and conduce to the widening of the lines and the reversal of some of them. Without a jar the amount of matter carried off the electrode also doubtless increases with the pressure and consequent resistance, and may be the cause of the weakening, as Cazin suggests, of the lines of the gas in which the discharge is passed. It is to be noted, moreover, that the disappearance of the hydrogen lines depends, in some degree, on the nearness of the electrodes. The lines C and F, which were, as above stated, sometimes invisible in the spark when the electrodes were near, became visible, under circumstances otherwise similar, when the magnesium points had become worn away by the discharge.

M. Ch. Fievez (*Bull. de l'Académie Royale de Belgique*, 1880, p. 91) has investigated the variations in the appearance of the spark spectrum of magnesium under certain different conditions. Using a Rutherford grating of 17,296 lines to the inch, he has noticed certain lines about the *b* group which increase in number with the order of the spectrum observed. He has also noticed dark lines in the solar spectrum corresponding to these lines of magnesium when the two spectra were superposed. We have noticed similar lines in the spectrum of magnesium given by a Rutherford grating, but attribute them to a different cause. The Rutherford gratings have a periodic inequality in the ruling, due to an imperfection of the screw of the ruling machine, in consequence of which the image of every bright line is accompanied by a series of fainter images at nearly equal distances on either side of it, diminishing rapidly in brightness as they recede from the principal line. These *ghosts* are so much fainter than the principal lines that they are not noticed in the case of any but bright lines, and except in the case of very bright lines only two, one on each side, are seen to accompany each principal line. The positions of these *ghosts* have been investigated by Mr. Pierce in the *Mathematical Journal*, of the Johns Hopkins University, Baltimore, who has found theoretically, and confirmed it by actual observation, that the distance between successive images of the same line is directly proportional to the dispersion and inversely as the order of the spectrum. Our own observations of the positions of the *ghosts* of the *b* group of magnesium lines in spectra of different orders agree closely with Mr. Peirce's theory, and two different Rutherford gratings both give us the same results. The annexed diagram gives the relative positions of the first pair of *ghosts* of each of the lines of the *b* group in the spectra of the third and fourth orders, when the angle between collimator and telescope is 45°. If this is compared with M. Ch. Fievez's map, it will be seen that he has probably been deceived by these *ghosts*, both in the solar spectrum and in that of the spark; but as he does not state the angle between his collimator and telescope, no exact comparison can be made. These ghosts are sometimes very embarrassing when many lines are in the field of view, but they may be detected by comparing the spectra of different orders, as the ghosts have different relative positions in the spectra of different orders. In the spectrum of the third order the first ghost of b_2 on the more refrangible side falls on b_4, and that of b_4 on its less refrangible side falls on b_2.

(To be continued.)

Chromous Bromide and Iodide, and Chromous Oxalate.—H. Moissan.—The author obtains anhydrous chromium bromide by reducing chromic bromide by hydrogen, by the action of dry hydrobromic acid at high temperatures upon fused chromium, and by passing vapours of bromine in a current of nitrogen over metallic chromium heated to redness. The iodide is obtained by similar methods, and the oxalate is formed by the action of oxalic acid upon chromous acetate in an atmosphere of carbonic acid, freed from oxygen.—*Comptes Rendus.*

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,
Member of the American Society of Civil Engineers.

(Continued from p. 254.)

Aqueous vapour (which is merely the accepted name for steam in its invisible condition below the boiling-point of water) is, like carbonic acid, an innocuous gas, quite harmless to animal life, except in so far as its presence in large proportions interferes with the natural secretions.

It would almost seem, from these statements as to the harmless character of respired gases, that the word "vitiated" was misapplied to exhaled air.

There is present in air, in general, a certain amount of gaseous impurities. Ammonia, sulphuretted hydrogen, and sulphurous acid gas, with numerous others of local derivation (especially near towns or cities), are found in very small quantities; so small that the hundredth of a per cent is to be taken as a unit in measuring them. But besides these gaseous impurities, there always exists in air of inhabited regions very small quantities of floating organic matter, composed of fragments of organic origin, vapours of the same source, like odours, for instance, microscopic germs or living organisms, together with dust of minerals, metals, smoke, &c., forming an insignificant part of the atmosphere, nearly inappreciable by weight or measure, but of the greatest importance in effect upon the air of ventilation.

The dangerous vitiations of air by respiration or by perspiration are those which proceed from the decomposable organic matter, exhaled or emitted. This organic matter appears to be carried to a large extent by the aqueous vapour, although much of it exists as floating dust; and small particles of skin, fatty substances, and bits of hair can be caught and identified by the microscope. The quantity of such organic matter is exceedingly diminutive as compared with any given volume or weight of air. Dr. Angus Smith (the only authority, but his authority is sufficient) concludes that not the one hundred-millionth part of its volume for pure air on high ground, or about the one five-millionth part in a crowded railway-carriage, is organic impurities. Yet to a very small portion of this very small portion of air is attributed the danger from breathing vitiated air. In all probability the origin of disease can be found only in atmospheric germs of living organisms, which find the perpetuation of their vitality in the decomposable and decomposing organic matter suspended in the atmosphere, and which are disseminated through the agency of the same atmosphere.

The quantity of carbonic acid exhaled in a given time by any number of persons is nearly uniform, and also the proportion in free air is quite uniform, so that the proportion of carbonic acid present in any occupied room can be taken to represent very accurately the degree of vitiation from respiration. Not that the carbonic acid itself is dangerous or unhealthy; but by its presence in excess of the normal quantity the organic matter proceeding from persons occupying the room, and the related unhealthiness, can be estimated. The measure, however, is not a positive one, as a relationship to the degree of moisture in the air of any room is one of the conditions of the decomposition of organic matter, so that vitiated air laden with moisture may be considered more dangerous than the same air comparatively dry, and this regardless of the carbonic acid present.

This very long preamble to the real subject of this paper has been made because the writer felt it necessary to substantiate fully his fundamental propositions as to the absolute and demonstrable quantities of air needed for ventilation.

So far as carbonic acid and vitiations proceeding from

* A paper presented to the American Society of Civil Engineers, January 26, 1881.

the breath are concerned, it is evident that only a little over one-third of a cubic foot of pure air is needed each minute, provided the entire volume of vitiated air be removed without mixture in the same time. So far as moisture or aqueous vapour emitted is concerned, about 4½ cubic feet per minute, supplied at 70 degrees and of 70 per cent of humidity, will suffice to prevent the deposition, if the air be evacuated at 70 degrees and in the condition of saturation; while if it be admitted that the effluent vitiated air of the room has a temperature of 72½ degrees, its condition of humidity when carrying the same amount of vapour will be only 90 per cent. Whence 4½ cubic feet of air per minute (under these conditions of supply) is enough to remove all vitiated air from personal sources, to furnish perfectly fresh, pure air for respiration, and to provide an *atmosphere* 4 or 5 inches thick around a standing individual, which *atmosphere* will ascend around him, and be supplied from beneath, at the rate of motion of about 3 or 4 feet per minute.

This proposition for the absolute ventilation of an individual has been stated in all its baldness to make its impracticable character emphatically evident. Men are not going to be ventilated in cases, even to secure perfectly fresh and healthful air. The purity of air in any occupied place can only be relative. The sole mode of removal of vitiated air possible is by diffusion and dilution. A much larger quantity of air will have been supplied or permitted to enter into a room, and will be removed or allowed to escape, than is needed for the use of the persons occupying the room, during the time of their occupancy of the same; and the room itself will have a definite cubical capacity, and form an intermixing chamber for the fresh and vitiated air.

We have now passed all exact computation, and come into a field of guesses and assumptions. With a definite supply of air to any room (which supposes in some way a corresponding efflux) a certain quantity of exhalations and emissions will eventually approximate to a definite ratio of the constituent parts of the air within the room. If it be supposed that twice the quantity of carbonic acid is admissible in a continuously occupied room, over that existing out of doors in fresh air, then ninety-five times as much air as is needed for respiration, &c., must be supplied to dilute the exhaled air,—a proportion which gives about 32 cubic feet of air per person per minute, with a result of 0·0008 volume of carbonic acid present. If it be supposed that the hygrometric condition of the air is limited to an *increase* of 5 per cent of the humidity in air of 70 degrees, then the absorption of vapour demands 25 cubic feet of air to each person per minute. These neat results from computation would be very satisfactory if there were any grounds for the assumption of 8 parts in 10,000 as the exact ratios for carbonic acid and air in rooms, or for acceptance of 5 per cent of humidity in place of some other ratio, smaller or larger.

The whole matter, then, resolves itself into opinions as to individual personal comfort, and to observations upon healthfulness of some of the very few rooms and places where, for a period of time, more or less extended, a definite ventilation has been maintained.

It seems pretty well established, for rooms continuously occupied by persons, either in good health or at least not subject to offensive disease, that 30 cubic feet of air per person per minute, if of proper temperature and humidity (temperature and humidity being considered to have related values), and if adequately introduced and removed into and from rooms which have a cubic capacity of not less than 1000 cubic feet per person, will pleasantly, healthfully, and satisfactorily ventilate such rooms.

When one considers the various conditions comprised in this rule, he will comprehend how generally inapplicable the fixed rule of 30 cubic feet per person per minute becomes. The condition of the persons as to health, &c., will change the figures from 30 to 60 for surgical or obstetrical wards in hospitals; while for some diseases even the larger quantity will not remove offence, and for yet others no quantity of air can be named sufficiently large. Increase of temperature and humidity, for degrees and percentages above 70 degrees and 70 per cent of humidity, begin to demand larger quantities of air for comparative comfort; with 90 degrees out-of-doors, and 60 to 70 per cent of humidity, even 60 feet per minute is not an excessive quantity of air, where 30 is named above.

The continuity of occupancy and cubic capacity are in some respects interchangeably related values. Where any room is to be occupied for a short time only, its cubic contents may be taken as so much fresh air, and deducted from the amount of air required for ventilating the same room for the same time. Thus let it be supposed the room itself has the cubic contents of 1800 feet; that one person alone occupies this room for an hour (supposing it to have been filled with fresh air at the commencement of the time), and that no fresh air is supplied during the hour; the degree of vitiation will only have reached the point which would, eventually, have been attained in a continuously occupied room, where 30 cubic feet of air had been regularly supplied each inmate. This almost self-evident proposition is of the highest importance in ventilation. The homes of those in humble circumstances, and even of those who live in moderate ease, are made healthful, not by abundant constant supply of fresh air, but by frequent freshenings of the air of dwelling or sleeping rooms. No systematic ventilation, however well devised and constructed, however extensive its supply of fresh air, however regularly or judiciously operated, can afford to dispense with repeated displacement of the air of rooms, and substitution of entirely fresh air through open windows and doors, at times during all seasons of the year. This law of change of air, taken in connection with a limited supply during time of occupancy, applies directly and at once to the halls of audience, the ventilation of which is the theme of this paper.

In all civilised countries people congregate in churches, halls, or theatres, for devotion, instruction, or amusement. The ends of government require legislative and council chambers, and court rooms, which have at times crowded sessions. There are thousands of rooms in this land, and in other countries, in which crowds are gathered, and often packed for sessions of one to six hours on the average, with occasional sessions, in some legislative halls in particular, of twelve and sometimes more than twenty-four hours. Anything may be called tolerable that is tolerated, anything may be esteemed endurable that is endured. Churches, halls, schools, theatres, state houses, court rooms, &c., are rendered tolerable when judicious care is taken in changing the air after a session, and in having fresh air in the audience rooms at the commencement of the same. They are endurable—not only can little illness or actual disease be traced to them as places of origin, but on the whole the audiences, accustomed or habituated to the closeness of the air which accompanies any lengthened session, cease to notice what would be excessively disagreeable to a new-comer into the confined room. People do not willingly find fault where there is apparently no remedy.

Perhaps the most striking example of this salutary effect of occasional change of air as a substitute for ventilation by constant supply, is to be found in our American railroad cars, where, in cold weather, the least of regular supply is furnished to largest number of persons temporarily crowded into the smallest space. To the outsider the heat becomes intolerable; to the insider it is more tolerable than any draft of fresh, cold air.

To the chemist, the air is found "vitiated" to the extreme, both with carbonic acid and with vapour of water, while it is laden with organic impurities that are hastening towards the condition of offensive decomposition. The unhealthful condition of the air in thousands of cars, on any day during six months of any year, cannot be questioned. And yet no serious illness that can be attributed to the want of ventilation is found amongst the tens of thousands of passengers, and it is well known that the

conductors, brakemen, and others connected with the trains, who live in and out of the cars from day to day, are healthy beyond the healthiness of most other men.

Comfort is found in warmth. Whatever supply of fresh air be given, not the slightest sensation of cold must be appreciated from the current of fresh air by any occupant of a room. There is only one exception to this dictum, and that is when a person, having come to a sense of oppression from the air of a room (a sense which is almost invariably one of heat and not of badness), voluntarily endures the admission of fresh cold air upon himself. Such a person will be more likely to enjoy a blast from an open window when the external air has the temperature of zero, than to endure a gentle current of 4 or 5 feet per second, of air at 60 to 65 degrees, and 45 to 50 per cent of humidity. The requirements of ventilation are not positive. Those of comfortable warmth are immutable facts. The air of any room may have become much vitiated, and even offensive, and if its temperature be kept down to the point of comfort most persons will deem such air to be fresh within the desirable degree of purity, while an overheated room is apt to be pronounced to be "filled with bad air," although the air may be as pure as is attainable.

The popular appreciation of ventilation is founded upon effluvia and heat. Effluvia may proceed from two sources: first, from the decomposition of organic matter exhaled or emitted (a very short time is needed for this decomposition to become apparent); and second, from odours which emanate from the person or clothing of those occupying a room, whether the odour be offensive or defensive. In either case effluvia, when marked as pervading a room, or any portion of it, is a legitimate evidence of inadequate ventilation. The effect of odours, however, on the senses is very imperfectly marked. A habitude is established, and nine persons out of ten of an audience do not realise the degree of vitiation which has been reached by gradual steps during a session, and at the end of the same, when passing to the outer air, the change of temperature will not allow the change of quality to be perceived. Unless one has had occasion to enter the hall during the sitting he will never know the air had become impure. Heat becomes, therefore, almost the sole standard by which ventilation of halls is judged. The overheated condition, especially of the upper portions of halls, obtains the designation of closeness, and is generally submitted to the limit of endurance, at which point some window near by is opened, greatly to the discomfort, in cold weather, of those on the floor of the hall, and little to the relief of the overheated portion of the room.

Except in very cold weather crowded halls do not require the supply of much heat. Many halls, with corridors and passages on one, two, or all sides, especially auditoriums of theatres, require no more than to be warmed to a comfortable temperature before the audience collects, after which the heat from the persons composing the audience will more than supply what heat is lost at the windows or walls. For ventilating a hall in such case it becomes necessary to introduce air of lower temperature than that of the room. The problem, then, is how to introduce and distribute cold currents of air amongst a crowded audience without producing the sensation of cold to any one of them.

The air supply demanded may not be strictly cold. Its desirable temperature may rise considerably above the proper temperature of the room, and yet it will, in currents, be perceptibly and sensibly cold.

The feeling of cold from currents of air proceeds from two sources. First, the abstraction of heat in warming the air itself; and second, from the absorption of vapour by the air, which vapour will have been formed at great expenditure of heat from the natural moisture of the skin. "The quantity of heat taken up in the vaporisation of the moisture of the skin by dry and cold air, compared with that abstracted in warming the air, is so great that the heat imparted to the temperature of the air becomes much the least in the ratio. Thus air at 35 degrees and of 70 per cent humidity demands nearly the same quantity of heat, to warm it to 70 degrees, that is requisite to vapourise the moisture which will raise the humidity to 75 per cent at 70 degrees.* It is very nearly correct to assert that the cool sensation from a breeze in summer proceeds entirely from the evaporation of moisture thereby induced. A current of saturated air at 100 degrees will neither remove heat by contact nor by induced evaporation, and is consequently incapable of producing a cooling effect; while as the temperature or the degree of humidity is supposed to fall, the same velocity of current becomes first a pleasant, cooling one, and next a decidedly cold one. With a high temperature and dry air the cooling effect of a current (even at 100 degrees) may be pleasant to the sensation, but will be attended by sun-burning (even without exposure to the sun), and blisters will be produced by the excessive deprivation of moisture, from the cuticle or surface of the skin. With 80 degrees of heat and a high dew point, a strong breeze is not unpleasant, nor likely to be injurious, after the person shall have acquired some accustomed habit of body to endure it; but at 70 degrees and a low dew point, which is the only possible condition of heated air in mid-winter, the annoyance of a current of even 5 feet per second and its unhealthiness are positive facts." †

It is proper that I should advert, at this point in my discussion, to the marked differences of the variations and requirements of warming and ventilating that exist in this country from those which are found in England or France. The subject has been considered in the Paper "On the Relation of Moisture in Air to Health and Comfort," but it may be now again referred to, in support of the view that American practice should be directed to meet the special requirements of American conditions, and not to conform with other requirements, however well established in themselves. As was set out in the Paper "On Moisture in Air," it seems at first inexplicable to an American how the statement can be made by foreign writers that 56° to 62° F. are comfortable temperatures for living rooms, when in cold weather he is scarcely warm at 70 degrees, and in mid-winter is not overheated at 80 degrees, although clad at the time in the thickest of under-clothing. The fact is that the deprivation of heat from the person is greater from the evaporation of moisture than from radiation or convection of the air, and the hygrometric state of the atmosphere has so much influence as to make a temperature of 56 degrees in Ireland, the West and South of England, or in Normandy, sensibly as warm as 80 degrees in Canada or Minnesota, at about the same season of the year.

All mankind complain of the weather, and an Englishman especially. But there are in England eight months of the year when the thermometer ranges between 40 and 60 degrees in the shade (and there is very little sunshine), with a dew point so high that it is a pleasure to exercise in the invigorating air; one month of 60 to 80 degrees; and three months from 25 to 50 degrees: while in Northern America there is scarcely one month (or thirty days) with the average temperature of 50 to 70 degrees (temperatures which, from the difference of humidity, correspond sensibly to 40 to 60 degrees in England), and there are about three months from 75 to 90 degrees, three months of 30 to 50 degrees, and five months of excessive variation of temperatures from zero to 40 or 50 degrees, these last five months having about thirty days of warm weather at intervals. During the three hot months, and also during the five cold ones, open-air exercise to those whose avocations are generally within doors is almost impossible. Anyone who is called upon to endure the fervid summer heat, or who will habituate himself to the inclemencies of

* *Vide* Addenda to Paper "On the Relation of Moisture in Air to Health and Comfort," which will be reproduced in a future number of the CHEMICAL NEWS.

† Quoted from a Paper by the author, "On the Ventilation of the Hall of Representatives, Washington," 1876.

our Arctic winter, will not suffer great discomfort therefrom; but the weak and the tender, the workman of the factories, the tradesman of the shops, the merchant in the counting-house, the student at the desk, cannot acquire the endurance or the habit, and must shelter or warm themselves.

It follows that the ventilation of halls in England for eight months of the year is simply the quiet introduction of a given quantity of external air, little or no increment of heat being necessary; and for three-twelfths of the year the similar introduction of air, heated 15 to 20 degrees. There is one month of altogether open windows; but, except on a few stormy days, there are few times when relief from overheat or closeness in a room cannot be obtained without serious discomfort, by partial or controlled admission of external air directly from windows. The small addition of heat demanded at any season, and especially for the most of the year, prevents the adoption of our system of ventilation by means of warmed currents of air. The use of the levity of the entering current ceases to be available when that current must necessarily be only very little, if at all, higher in temperature than the room itself. On the other hand, the operation of an exhaust system, where an exhaust shaft or fan is made to remove air from the room, becomes eminently feasible, when the general conditions are such that the outer air may be taken in freely, at any provided or arranged inlet, without discomfort from its want of heat. The great support of the exhaust system for American usage is derived from English authority and example, together with its applicability to ventilation for the American single month of the year, of 50 to 70 degrees, when closed windows and a supply of unheated air is the requisite for occupied places.

Our season of open windows is longer than that of England, but it is also much hotter, and we are constrained to some forced supply of air during the hot season to render audience halls tolerable. Our term of mean temperature is so brief that its especial consideration may be neglected for audience halls, but for asylums or hospitals this term must be adequately provided for. The real point of discussion is how to warm with an average temperature outside of 25 to 30 degrees to the inside temperature of 70 to 75 degrees, and how to supply, with the warming, sufficient air for breathing and for the preservation of relative purity.

There are two respects in which ventilation of halls becomes easier in America than in England. The greater humidity of the English climate prevents the dispersion of exhaled vapour with the same rapidity as with us, and exhaled vapour is laden with organic impurity on the verge of decomposition. Only a very few minutes are required for surcharged air at the temperatures usually existing in close rooms to become offensive. The fœtor of a long-occupied hall in England is distinctive to an American, and unapproachable in a drier climate. In another regard we have, in the court rooms, theatres, and public buildings in general in America, the advantage of superior cleanliness in dress and person for a considerable portion of the audiences. We have comparatively no lower order to ventilate against.

(To be continued.)

ON MANGANESE IN STEEL.

By SERGIUS KERN, M.E., St. Petersburg.

Many works using inferior materials for the production of cast-steel, either by the Bessemer or open-hearth processes, add a notable quantity of spiegeleisen, or ferro-manganese; in steel cast by such works, some 0·60 to 1·00 per cent of manganese is often detected. Certainly, such a steel is good for many purposes, but in some cases (as for the preparation of plates for boiler-making and ship-building) it is a serious question if it is proper to use such a material, the corrosive property of which is very high and bending tests bad. The author believes that inspectors, before passing plates for the above-mentioned purposes, should be instructed to make acquaintance with the chemical composition of the steel; by such means much confusion may be avoided.

Some Bessemer steel plates for boilers, on being analysed, gave the following results:—

Carbon	0·18 per cent.
Manganese	0·65 ,,

The ingots for the manufacture of these plates, rolled capitally well, and stood a higher heat than Siemens-Martin ingots containing:—

Carbon	0·18 per cent.
Manganese	0·24 ,,

But in respect to the bending tests, these Bessemer and Siemens-Martin plates behaved quite differently, plainly showing the hardening effects of manganese:—

A.—*Bessemer Plates.*

Specimen re-heated and cooled in sand ..	Bent double.
Specimen heated to a yellow heat and cooled in water	Broke at a bend of 25°.

B.—*Siemens-Martin Plates.*

Specimen re-heated and cooled in sand ..	Bent double.
Specimen heated to yellow heat and cooled in water	Bent double.

It must be added that the contents of silicon, sulphur, and phosphorus were, on the average, nearly the same, both in Bessemer and Siemens-Martin steel.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, from April 20th to May 19th, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington

To the Right Honourable the President of the Local Government Board.

May 20th, 1881.

Sir,—Herewith we submit for your consideration the results of our daily examinations of the water supplied to the Metropolis by the seven London Water Companies deriving their supply from the Rivers Thames and Lea for the month ending May 19th.

We have as heretofore taken every care to obtain trustworthy samples of the water delivered from the mains of the several companies. The places and times at which the samples were collected are duly stated in the tables.

The waters generally have shown a continued improvement during the past month, and have reached, somewhat earlier in the year than usual, a condition (so far as the presence of organic matter is concerned) of extreme purity.

In 9 only of the 182 samples examined were we able to detect the minutest trace of matter in suspension. The colour of the waters, as seen in the two-foot tube, has been daily determined by the process described by us in a former report. It has been as nearly as possible of the tint of distilled water throughout the whole month.

In Table I. we have recorded the analyses in detail of samples, one taken daily between April 20th and May 19th. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

In Table II. is recorded the colour together with the clearness or turbidity of each sample. Of the 182 samples collected by us between the dates mentioned above, 173 were found "*clear*," and 9 were noted as "*very slightly turbid*."

Of the 26 samples supplied by the New River Company, 1 was found to be "very slightly turbid." The remaining 25 samples being clear, bright, and efficiently filtered.

Of the 26 samples from the mains of the East London Company, 4 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were bright, clear, and well filtered.

Of the 26 samples from the mains of the West Middlesex Company, 2 were found "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 26 samples from the mains of the Lambeth Water Company, 2 were found "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 26 samples from the mains of the Grand Junction Company, the whole were clear, bright, and well filtered.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were clear, bright, and efficiently filtered.

When a trace of suspended matter is noticeable, we record the water as "turbid." When on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid." A water is recorded as "slightly turbid" when we consider it to come between those two extremes.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen in the whole of the samples collected.

The waters supplied during the month have been uniformly clear, bright, and almost colourless, proving that they have been well and efficiently filtered.

Examined chemically they have shown excellent aëration and great freedom from organic matter. They leave nothing to be desired for dietetic purposes.

We remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 2, 1881.

Prof. H. E. ROSCOE, President, in the Chair.

THE following certificates were read for the first time:—W. Rupp, J. D. Custance.

It was announced that a ballot for the election of Fellows would be held at the next meeting (June 16).

The following papers were read:—

"*On the Action of Solvents on Saponified Oils and Waxes*," by A. H. ALLEN and W. THOMSON. No satisfactory process at present exists for the analysis of mixtures of hydrocarbons with animal and vegetable fatty matters, although a correct determination is often of considerable practical importance. The process at first adopted by the authors is as follows:—10 grms. of the sample are weighed out into a 5" evaporating dish, 50 c.c. of an 8 per cent solution of caustic soda in absolute alcohol added, and the whole gently boiled with stirring until frothing occurs. 15 c.c. of methylated spirit should now be added, and heat applied till the saponified oil is dissolved. 5 grms. of sodium bicarbonate are then gradually added with constant stirring, and lastly 50 to 70 grms. of clean ignited sand are stirred in. The whole is then dried for twenty minutes in the water-oven. The mixture is transferred to a large test-tube, having an aperture at the bottom plugged loosely with glass-wool. The tube is placed in a Xoxhead's fat extractor (a rather larger size than that usually made) adapted to a small tared flask containing 100 c.c. of petroleum spirit (boiling below 80°). When the extraction is complete, the petroleum spirit is distilled off, and the dry residual matter weighed. By using this process the authors obtained the following percentages of unsaponifiable matter:—Lard, 0·23: olive oil, 0·75; German rape oil, 1·00; cotton seed oil, 1·64; cod-liver oil, 1·32 and 0·46; sperm oil 39·14 and 51·31; spermaceti, 40·64; bees'-wax, 52·38; Carnauba wax, 54·87; Japan wax, 1·14; rosin oil, 98·72; mineral lubricating oil, 99·90. In the case of the cod-liver oil, the unsaponifiable matter contained cholesterin. With spermaceti and the waxes this matter left a sensible proportion of ash, doubtless because the solution of melissyl or cetyl alcohol in petroleum spirit acted as a solvent for sodium soaps. The authors tried to avoid this inaccuracy by forming calcium and magnesium soaps, but without success. They also investigated the action of various solvents on the sodium soaps from various oils. They found, too, that the hydrocarbon oils, when present in quantity, exercised a similar solvent action; so that while the process above described gives accurate results with unmixed animal or vegetable fats, and with unmixed hydrocarbon oils, with mixtures of the two classes the method was unreliable. In such cases they recommend the following:—5 grms. of the sample are treated in an evaporating dish with 25 c.c. of alcoholic soda, and the mixture boiled until it froths. 50 c.c. of warm water are added to dissolve the soap, and the solution transferred to a globular glass separator of about 200 c.c. capacity, furnished with a tap below and stopper at the top. The basin is rinsed out with 20 to 30 c.c. of water, and then 30 to 50 c.c. of ether added. The whole is then thoroughly mixed. The separation of the ether can be hastened by cooling or by the addition of a few c.c. of alcohol. The soap solution is run off, the ether washed, and the washings drained off. The etherial solution of the unsaponifiable matter is then run into a tared flask, and distilled to dryness. The soap solution must be agitated a second and third time with ether if great accuracy is required. In order to test the accuracy of the process the following mixtures were analysed:—

Mixture.	P.c. of Mineral or Resin Oil.	Found Per cent.
Olive and shale oil ..	60	58·028
" " " ..	20	19·37
Olive and resin oil.. ..	60	53·05
	60	59·42
	20	19·61
Lard and paraffin wax ..	40	40·48

The authors promise further investigations on the higher alcohols from the waxes, and also an examination of the products of the saponification of Japan wax.

"*Experimental Researches on the Amalgamation of Silver Ores*," by C. RAMMELSBERG. The author gives the results of many quantitative experiments as to the reactions which take place in the Mexican amalgamation process. He has investigated the actions of cupric and cuprous chlorides on silver, silver chloride, silver sulphide, arsenic sulphide, antimony sulphide, and on complex combinations, particularly sulpharsenide and sulphantimonide of silver.

"*On the Sulphides of Copper, and a Determination of their Molecular Weights*," by S. U. PICKERING. The cupric sulphides were prepared by precipitation by hydrogen sulphide, and by heating electrotype copper with strong sulphuric acid at 180° C. for thirty minutes; the cuprous sulphides by heating pure copper with strong sulphuric acid at 124° for thirty minutes, and by partial reduction of cupric sulphide in a current of hydrogen. The author

has investigated the action of hydrogen and carbonic anhydrides on the sulphides, and has also heated the sulphides alone. When cupric sulphide is heated in a slow current of hydrogen, hydrogen sulphide begins to be evolved at about 200° C., and between that temperature and 265° the cupric is converted into cuprous sulphide. On raising the temperature no further reaction is noticed until a red-heat is nearly reached (580° to 650° C.), when the whole is reduced to the metallic state. Cupric sulphide, when heated in a current of carbon dioxide, exhibits similar phenomena. At 130° to 150° cuprous sulphide is formed; at 230°, metallic copper. When cupric sulphide is heated to a sufficiently high temperature in a gas which has no reducing action upon it, half the sulphur is evolved, and cuprous sulphide is left. As the sulphur is obviously eliminated in two distinct steps, the author concludes that the formula of cupric sulphide must be doubled, and is therefore Cu_2S_2.

Dr. ARMSTRONG, while admitting the extreme probability of the view suggested by Mr. Pickering, did not think that the fact that the sulphur was given off in two steps was quite sufficient proof that the formula should be doubled.

Mr. PICKERING said that the only other explanation was that part of the sulphide was reduced to metallic copper, which immediately combined (at such a low temperature) with another portion of unaltered cupric sulphide. This seemed to him very improbable.

The next paper was read by Mr. J. C. THRESH, and was entitled "*Chemical Examination of the Buxton Thermal Water.*" The author first had his attention attracted by the extraordinary statement of Playfair that this water contains 206 cubic inches of nitrogen gas per gallon. Muspratt increased the quantity to 504 cub. inches. The author has repeated these determinations, but could only find about 22 c.c. of N per litre. The erroneous results of Playfair and Muspratt seem to have been obtained as follows:—The gas which is found over the spring contains N 98·98 per cent, CO_2 1·02. They estimated the CO_2 in the water, and assumed that the same proportion existed between the gases dissolved in the spring as was found in the gases evolved by the water. They completely overlooked the fact of the greater solubility of CO_2 in water. The gases dissolved in a litre of water are 22 c.c. N and 14·5 c.c. CO_2. The mean composition of the gas dissolved in the water is therefore 59·78 per cent N, 40·23 CO_2, which, by calculation from the coefficients of absorption of CO_2 and N, should evolve a gas containing 99·12 per cent N, 0·88 per cent CO_2. The author gives details of the method employed by him in collecting and analysing the gas. He has also made a complete mineral analysis of the mud deposited by the spring: it contains 71·1 per cent Mn_3O_4, 1·08 per cent of matter insoluble in HCl, 0·02 per cent molybdic acid, 0·30 per cent cobalt oxide, 5·3 per cent lime, 1·36 per cent iron and aluminium oxides. The presence of the molybdic acid was confirmed by the yellow precipitate with sodium phosphate, &c. The author suggests that the large quantity of nitrogen may be accounted for by supposing the water to have been at one time saturated with air from which the oxygen has been removed by the lower oxides of manganese.

Mr. THOMAS said that a spring near Cardiff similarly evolved a large quantity of nearly pure nitrogen. In this case he had traced the nitrogen to a shale containing large quantities of that gas.

The PRESIDENT then exhibited some specimens illustrating the synthetical production of indigo by Baeyer, also a magnificent specimen of isatin lent by Dr. Schunck.

The SECRETARY then read a paper by E. J. MILLS "*On Potable Waters (Part II. Determination of Total Solids).*" The author suggests that this determination should be made by accurately observing the time which a glass bulb takes to rise through a measured depth (22 centimetres) of the water. Care must be taken that all the surfaces are clean and that the temperature is constant. The time was taken by a metronome beating thirds of seconds. This method determines every constituent that is foreign to distilled water.

The following paper was also read by the SECRETARY: "*On the Estimation of the Value of Zinc Powder, and on a Gauge for Measuring the Volume of Gases without Calculation for Temperature and Pressure,*" by J. BARNES. The value of the zinc powder was estimated by the amount of hydrogen evolved. The hydrogen is measured by the quantity of water which it displaces. The gauge consists essentially of a narrow graduated tube placed in mercury; on the upper end of the tube a bulb is blown. The value of the graduation is determined. On exposing this bulb to the temperature and pressure at which the gas is being measured, reading off the division at which the mercury inside and outside is level, and referring to a table, a number is obtained. The observed volume of the gas is divided by this number, and the corrected volume at once obtained.

The Society then adjourned to June 16, when a ballot for the election of Fellows will be held and the following papers read:—"On the Isomeric Acids Obtained from the Ethers of Salicylic Aldehyd and from Coumarin," by W. H. Perkin; "Notes on Naphthalene Derivatives," by H. E. Armstrong; "On the Synthetical Production of Ammonia," by G. S. Johnson; "On the Sulphates of Aluminium," by S. Pickering.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, June 6, 1881.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

C. J. S. SPEDDING, Mrs. Katharine Maria White, and Captain Henry Tryon Wing were elected Members of the Royal Institution.

The special thanks of the members were voted to Mr. William Ladd for his valuable present of a dynamo-magneto-electric machine and platinum wire apparatus.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

AMERICAN CHEMICAL SOCIETY.*

May 6, 1881.

Prof. A. R. LEEDS in the Chair.

In the absence of a quorum, the regular business was deferred till one should be present.

The first paper of the evening, "*On a Slight Modification of the Wilkinson Gas Eudiometer,*" was then read by JAMES H. STEBBINS, Junr., S.B. The modification described consisted in having the glass stopcock soldered directly on the top of the eudiometer, instead of the long thin neck previously used.

Some remarks were then made by Prof. Doremus, after which the second paper of the evening, "*On the Purification of Baric Sulphate,*" by T. O'C. SLOANE, Ph.D., was read.

The third paper of the evening, "*On a Qualitative Test for Carbon Disulphide and Carbon Dioxide in Coal Gas,*" by T. O'C. SLOANE, Ph.D., was then read.

The Recording Secretary then announced that a quorum was present. The minutes of the previous meeting were read and approved.

Some discussion then followed, participated in by Messrs. Squibb and Casamajor, after which, the minutes of the previous meeting of the Board of Directors was read and approved after a small correction.

* Communicated by James H. Stebbins, Junr., Recording Secretary.

The following gentlemen were then unanimously elected:—C. P. Sawyer, Associate Member; proposed by Arthur H. Elliott, Elwyn Waller, P. Casamajor. A. Howard Van Sinderen, Associate Member; proposed by Arthur H. Elliott, T. O'C. Sloane, J. B. F. Herreshoff. Dr. Otto Grote, Member; proposed by S. A. Goldschmitt, Bernard G. Amend, James H. Stebbins, Junr. J. G. Mattison, Member; proposed by P. de P. Rickets, Arthur H. Elliott, C. F. Chandler.

The following gentleman was then proposed as a regular Member. A. P. Hallock, Ph.D.; proposed by T. O'C. Sloane, M. Benjamin, and Wm. Rupp.

The fourth paper of the evening, "*Upon the Direct Conversion of Aromatic Amides into their Corresponding Azo-compounds*," by A. R. Leeds, Ph.D., was then read. Dr. Leeds presented some additional results obtained by the treatment of aromatic substances with hydrogen peroxide. In a former communication, Dr. Leeds had stated that when palladium foil, saturated with hydrogen, was left in contact with pure water and purified air in a flask for several days, an amount of hydrogen peroxide was formed sufficient to be examined by various qualitative tests, and permitting of ready quantitative determination. The experiment was tried in order to discover by what reaction phenol is formed when, as originally pointed out by Prof. Hoppe-Seyler, hydrogenised palladium is left in contact with benzene and water. That it is really due to the substitution of hydrogen by hydroxyl, and not, as inferred by Hoppe-Seyler, to the action of oxygen rendered active by the oxidation of the hydrogen liberated in the nascent state from the palladium foil, was further shown by an experiment in which benzene was changed to phenol by boiling with hydrogen peroxide. In the latter experiment some oxalic acid and brown colouring matter were formed as well. Naphthalene was partly converted by similar treatment into naphthol, and anthracene was entirely changed to anthraquinone. Phenol and naphthol were little affected at ordinary temperatures, while on heating with hydrogen peroxide they were converted into tars. Nitrobenzene and benzenesulphonic acid were not changed. Diphenylamine, dimethylaniline, naphthylamine, xylidine, and orthotoluidine in glacial acetic acid solution, were changed mostly into tarry bodies, along with certain colouring matters. From these products, no crystallisable compounds could be separated by sublimation or by solvents. Paratoluidine, however, was converted into parazotoluene (M. P. 143° to 144°), crystallising in long brilliant orange needles, and aniline into azobenzene.

After some questions by Mr. Stebbins, the fifth paper of the evening, "*On the Chemical Contents of the Fluid Cavities of Minerals*," by Mr. A. A. Julien, was then read.

Some remarks by Messrs. Elliott and Doremus then followed. After which the Society adjourned.

CORRESPONDENCE.

THE SO-CALLED "BUNSEN"-PUMP.

To the Editor of the Chemical News.

Sir,—Permit me the space of a very few lines by way of rejoinder to Dr. Sprengel's remarks in your issue of the 3rd inst.

It would appear that the sore point with Dr. Sprengel is the use of the word "pump" in its connection as "Bunsen-pump" or "filter-pump." Had the apparatus been termed simply Bunsen's filter, or filter-apparatus, there would have been no offence to attach. Hence, I suppose, the reference to a variety of apparatus into certain connection with which the Sprengel-pump comes, and the query in effect—Why are not all these things called pumps? In any case all will allow that Dr. Sprengel is the inventor of the *water air-pump*, but not of the *Bunsen-filter*, which differs as a whole—according to Dr. Sprengel's own showing—from the pump itself as widely as a Bunsen's burner does from a spectroscope! Finally, to quote another paragraph in the letter in question, Dr. Sprengel says—"In our utilitarian age one is expected not only to build a ship on a new principle, but to sail her as well, and discover an America. This is hardly fair to the shipbuilder." To carry out Dr. Sprengel's metaphor, I cannot see for my part either that a shipbuilder is necessarily expected to navigate his own ship, newly invented or otherwise, or that the inventor of an apparatus is to be expected necessarily to apply his own invention in any or every direction; but, on the other hand, the "sailing the ship and discovering an America" by its aid involves just that combination of means to a great and beneficent end which has made famous the name of Columbus.—I am, &c.,

Verax.

BAROMETER PUMPS.

To the Editor of the Chemical News.

Sir,—I am much obliged by your having published my letter on this subject. You are quite right in stating that the barometer pump which I invented in 1847 is a different instrument from that invented by Dr. Sprengel about 1864. As long as he confined his claim to being the inventor of the instrument which he really did invent I had no right to interfere, but in your pages, and in another magazine, he has put forth the claim to being the owner of the *principle* of these instruments, and your correspondent "Verax" has credited Dr. Sprengel with the right to this claim, which I dispute. First, because no man can invent a *principle*; and, secondly, no man can obtain a patent for a *principle*. In my patent of 1847 I do not claim to be the inventor of the *principle* of the barometer pump, but I claim to be the first party who applied a barometer pump for any purpose whatever. The application I put the barometer pump to was for the emptying vacuum pans of sugar without destroying the vacuum. Dr. Sprengel subsequently followed my footsteps by applying a barometer pump for another purpose, and he has a right to be considered as the inventor of the instrument he planned, but his barometer pump and my barometer pump depend for their action on one and the same principle, and I am the first party who applied that principle in the form of a barometer pump, and I am the first inventor of a barometer pump and the father of barometer pumps. Hoping that you will find room for this.—I am, &c.,

James Johnstone.

Experiment Rooms, 1, James Square, Edinburgh, June 4, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 18, May 2, 1881.

Inverse Electro-Motive Force of the Electric Arc.—J. Jamin.—The author shows that every continuously acting machine, every battery, or accumulator, like those of Planté or Faure, is less efficient as a source of electric light than magneto-electric machines with alternating currents like those of Gramme.

Examination of Certain Artificial Minerals Produced by James Hall.—F. Fouqué and M. Lévy.—The authors have been requested by M. Daubrée to examine certain artificial products in his possession, obtained at the end of the last century by James Hall. They con-

clude that Hall was the first who succeeded in reproducing artificially an eruptive crystalline rock.

Salicylic Acid and its Applications.—M. Schlumberger.—This acid in very small doses checks the action of the nitrogenous ferments, with which it forms stable compounds. It is also advantageously employed in the preservation of articles of food.

Principle of the Conservation of Electricity, or Second Principle of the Theory of Electric Phenomena.—G. Lippmann.—The sum of the quantities of free electricity is invariable, since its total variation is always equal to zero. This law the author calls the principle of the conservation of electricity.

Acetylic Derivatives of Cellulose.—M. Franchimont.—The author, on treating cellulose with acetic anhydride to which a little sulphuric acid has been added, obtains two new bodies.

Action of Sulphuric Acid upon Acetic Anhydride. M. Franchimont.—The author obtains acetyl-sulphuric acid, which passes into sulphacetic acid.

Reagent for Distinguishing the Ptomaines from the Vegetable Alkaloids.—P. Brouardel and E. Boutmy.—If a substance isolated by the method of Stas behaves with potassium iodo-mercurate as do the vegetable alkaloids, and if it has no action upon potassium ferricyanide, a vegetable alkaloid is present. If the ferricyanide is reduced to ferrocyanide, whilst the base is also precipitated by an iodo-mercurate, it is a ptomaine. In applying the test the base extracted from the body under examination is converted into a sulphate, and a few drops of the solution of this salt are placed in a watch-glass which already contains a little ferricyanide dissolved. A drop of neutral ferric chloride added to the mixture gives a precipitate of Prussian blue if the base isolated is a ptomaine.

A Compound of Iodoform and Strychnine.—M. Lextrait.—The compound in question results from the combination of 1 equiv. strychnine and 3 equivs. iodoform. An analogous compound is formed with quinine.

Journal für Praktische Chemie.
Parts 13 and 14, 1880.

Liquid Phosphorus Sulphide.—H. Schulze.—The author concludes that the liquid sulphides of phosphorus are not true chemical compounds. Sulphur and phosphorus in these combinations reach the limits of the physical divisibility. In processes of solution only one of two bodies loses its solid condition, the other being already liquid. Here both components pass from the liquid to the solid state by the mutual attraction of their molecules. Liquid phosphorus sulphide is no more a mechanical mixture than a chemical compound, and ranks with the great number of manifold arrangements of matter which owe their origin to molecular forces without being molecular compounds from the point of view of modern chemistry.

The Atomic Weight of Antimony.—R. Schneider.—A reply to H. Kessler's paper (*Berichte Chem. Gesell.*, 1879, p. 1044, and *Journal für Prakt. Chem.*, 21, 114). The author confirms the accuracy of his former determinations, and gives the atomic weight in question as 120·182.

Di- and Tri-Carbinols.—H. Kolbe.—As far as our present experience extends all the compounds known as aromatic contain a trimethin or tricarbin radicle, phenyl, or its derivatives. Acetic and benzoic acids are distinguished from each other, not thereby that the atoms in the former form an open and in the latter a closed ring, but that acetic acid possesses a mono-carbine methyl, whilst benzoic acid has a tricarbine phenyl in combination with carboxyl. We have at present no accurate definition of fatty and aromatic compounds, but may perhaps arrive at it if we distinguish three classes of organic compounds: 1, such as contain mono-carbines only; 2, those in which dicarbines are present, alone or along with mono-carbines; and 3, those which contain tricarbines. To the first class belong the fatty acids, their alcohols, aldehyds, and ketones; to the second the bibasic acids with their alcohols, &c., and the majority of the carbohydrates; and to the third class all those compounds which we name aromatic.

Results of the Norwegian Expedition to the Polar Seas.—L. Schmelk.—The results are given in a series of six tables.

A Contribution to the Knowledge of Coal.—Dr. H. Reinsch.—The author considers it probable that he has discovered chenopodine in coal.

Chemistry of Gall.—G. Hüfner.—The author calls attention to "Herodotus" (Book IV., Cap. 58), where it is asserted that cattle fed on the grass growing in Scythia have a larger supply of gall than others. He hopes that some chemist living in Southern Russia will examine the fresh ox gall of that country as to its behaviour with hydrochloric acid and ether.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 13, No. 10.

Vapour-Density of Iodine.—V. Meyer.—In this paper the author discusses the criticism to which his works have been submitted by M. Crafts, and pronounces the objections to his earlier determinations of temperature well-founded. The objections to his determinations of vapour-density he thinks baseless, and announces that his former statement of the vapour-density of iodine at about $1050° = \frac{3}{2}I_2$ as confirmed by repeated experiments.

α-Nitroso-propionic Acid.—H. Gutknecht.—The author describes the properties of this acid, which, on reduction with tin and hydrochloric acid, yields alanine.

The Relations between the Physical Attributes of Bodies and their Chemical Constitution (Second Communication: See xii., p. 2135, and *Liebig's Annalen*, 200, 139).—J. W. Brühl.—The author states as the result of his researches that the atomic refraction of chlorine, bromine, and iodine, is unchangeable, the polyvalent elements only possessing a varying atomic refraction.

Chemisches Central-blatt.
Vol. 11. No. 37.

Spectroscopic Researches.—G. L. Ciamician.—Carbon has two spectra, one of the first and one of the second order, and this follows the general rule that each element has two spectra. Among the carbon compounds only cyanogen, carbon monoxide, and acetylene have peculiar spectra.—*Wiener Anzeiger*, 1880, 138.

Decomposition of Simple Organic Compounds by Zinc Powder.—H. Jahn.—Zinc powder acts upon the alcohols and analogous compounds, chiefly by removing hydrogen. Acids and certain of their derivatives yield corresponding ketones, carbonic acid and water being split off.—*Wiener Anzeiger.*

Action of Mercurethyl upon the Iodides of the Hydrocarbons.—W. Suida.—Mercurethyl and allyl-iodide mutually decompose each other at 120°.—*Wiener Anzeiger.*

On Ozone.—O. Liebreich.—We know nothing of an exact determination of ozone, and as if imbibed it is at once destroyed, its therapeutic action is inconceivable.—*Deutsch. Med. Wochenschrift.*

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
December, 1880.

This issue contains no chemical memoirs.

THE CHEMICAL NEWS.

Vol. XLIII. No. 1125.

ON THE

SPECTRUM OF MAGNESIUM UNDER VARIOUS CIRCUMSTANCES.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

(Concluded from p. 214.)

The Magnesium-hydrogen Spectrum.

In the *Proc. Roy. Soc.*, vol. 27, p. 494, and vol. 30, p. 93, we have recorded a series of experiments which led us to attribute to magnesium together with hydrogen a peculiar spectrum. This spectrum we have on no occasion been able to detect in the absence of hydrogen. Observations on the spark discharge in nitrogen, in carbonic oxide, and in hydrogen, at reduced pressures, confirmed the results given in the first-mentioned paper, when the discharge was taken in the gases at atmospheric pressure. It was further shown that this peculiar spectrum could be reversed during the voltaic discharge in a lime crucible, provided magnesium and hydrogen were both present, but not in the absence of hydrogen. Likewise the flame of burning magnesium was found to emit this spectrum when the combustion occurred in an atmosphere containing either free or combined hydrogen. In summing up our results the following opinion was expressed:—

"The experiments above described, with nitrogen and carbonic oxide at reduced pressures, are almost if not quite conclusive against the supposition that the line at 5210 is due merely to the lower temperature of the spark in hydrogen. From De La Rue and Müller's observations it would appear that nitrogen at a pressure of 400 millims. should produce much the same effect on the spark as hydrogen at 760 millims. Now the pressures of the nitrogen and carbonic oxide were reduced far below this without any trace of the line in question being visible. Moreover, the magnesium line at 4481, which is not seen in the arc, and may be reasonably ascribed to the higher temperature of the spark, may be seen in the spark at the same time as the line at 5210 when hydrogen is present. Nevertheless, temperature does seem to affect the result in some degree, for when a large Leyden jar is used, and the gas is at the atmospheric pressure, the line almost disappears from the spark, to reappear when the pressure is reduced; but by no variation of temperature have we been able to see the line when hydrogen was carefully excluded.

"A line of the same wave-length has been seen by Young in the chromosphere once. Its absence from the Fraunhofer line leads to the inference that the temperature of the sun is too high (unless at special times and places) for it sproduction. If it be not due to a compound of magnesium with hydrogen, at any rate it occurs with special facility in the presence of hydrogen, and ought to occur in the sun if the temperature were not too high.

"We have been careful to ascribe this line and its attendant series to a mixture of magnesium and hydrogen rather than to a chemical compound, because this expresses the facts, and we have not yet obtained any independent evidence of the existence of any chemical compound of those elements."

This spectrum (of which a figure was exhibited) consists of two sets of flutings, closely resembling in character the hydrocarbon flutings, each fluting consisting of a multitude of fine lines closely set on the less refrangible side, and becoming wider apart and weaker towards the more refrangible side, but extending under favourable circumstances much further than is shown in the figure. The set in the green is the stronger, and it was to this that our former observations were confined. It has two flutings, one beginning at about wave-length 5210 and the other close to *b*, on its more refrangible side. The other set consists of three principal flutings, of which the first begins at about wave length 5618, the next at about wave-length 5566, and the third begins with three strong lines at about the wave-lengths 5513, 5512, 5511. Both sets are very well seen when a magnesium wire is burnt in the edge of a hydrogen flame, and in the arc in a crucible of magnesia when a gentle current of hydrogen is led into it.

As Mr. Lockyer, in a paper entitled "A New Method of Spectrum Observation" (*Proc. Roy. Soc.*, vol. 30, p. 22), has brought forward this spectrum as illustrative and confirmatory of his views regarding the possibility of elemental dissociation at different heat-levels, we have been induced to review our former work. The view taken by Mr. Lockyer may be expressed in his own words.

"The flame spectrum of magnesium perhaps presents us best with the beautiful effects produced by the passage from the lower to the higher heat-level, and shows the important bearing upon solar physics of the results obtained by this new method of work. In the flame the two least refrangible of the components of *b* are seen associated with a line less refrangible so as to form a triplet. A series of flutings and a line in the blue are also seen. On passing the spark all these but the two components of *b* are abolished. We get the wide triplet replaced by a narrow one, the two lines of *b* being common to both.

"May we consider the existence of these molecular states; if so, then the metals will exist in different molecular groupings, and we shall be able, by spectrum observations, to determine the particular heat level to which the molecular complexity of the solid metal, induced by chemical affinity, corresponds. Examples.—None of the lines of magnesium special to the flame spectrum are visible in the spectrum of the chloride either when a flame or a spark is employed."

In order to ascertain if this spectrum could be produced at a high temperature in the presence of hydrogen, which we have already shown to be essential to its production at the atmospheric and at reduced pressures, the series of experiments already mentioned in describing the spark spectrum were made with hydrogen at pressures increasing up to twenty atmospheres.

On the supposition that this spectrum originates from the formation of some chemical compound, probably formed within certain limits of temperature when vapour of magnesium is in presence of hydrogen, the stability of the body ought to depend largely on the pressure of the gaseous medium. Like Graham's hydrogenium, this body might be formed at a temperature at which it would be usually decomposed, provided the pressure of the hydrogen were correspondingly increased. In fact, it has been shown by Troost that the hydrides of palladium, sodium, and potassium all follow strictly the laws of chemical dissociation enunciated by Deville; and increased pressure by rendering the compound more stable, provided the secondary effect of such pressure in causing a higher temperature in the electric discharge were not overpowering, ought to conduce to a more continuous and brilliant spectrum of the compound. Conversely, if such a more continuous and brilliant spectrum be found to result, in spite of the higher temperature, from increased pressure, it can only be explained by the stability of the substance being increased with the pressure.

Now what are the facts? When the spark of an induction coil, without a Leyden jar, is passed between magnesium electrodes in hydrogen at atmospheric pressure, the flutings in the green are, as before described, always seen, but they are much stronger at the poles and do not

* A Paper read before the Royal Society, May 12, 1881.

always extend quite across the field. As the pressure is increased, however, they increase in brilliance and soon extend persistently from pole to pole, and go on increasing in intensity, until at fifteen and twenty atmospheres, they are equal in brilliance to the *b* group, notwithstanding the increased brightness these have acquired by the higher temperature, due to the increased pressure. The second set of flutings, those in the yellowish green, come out as the pressure is increased, and, in fact, at twenty atmospheres only the *b* group and the fluting are noticeable; if the yellow magnesium line be visible at all it is quite lost in the brilliance of the yellow flutings. The tail of fine lines of these flutings extend at the high pressure quite up to the green, and those of the green flutings quite up to the blue. On again letting down the pressure the like phenomena occur in the reverse order, but the brilliance of the flutings does not diminish so rapidly as it had increased. If, now, when the pressure has again reached that of the atmosphere, a large Leyden jar be interposed in the circuit, on passing the spark the flutings are still seen quite bright, and they continue to be seen with gradually diminishing intensity until the sparks have been continued for a considerable time. It appears that the compound, which had been formed in large quantity by the spark without jar at the higher pressures, is only gradually decomposed, and not re-formed, by the high temperature of the spark with jar. This experiment, which was several times repeated, is conclusive against the supposition that the flutings are merely due to a lower temperature. When the pressure was increased at the same time that the jar was employed, the flutings did not immediately disappear, but the expansion of the magnesium lines and the increase of the continuous spectrum seemed to overpower them.

When nitrogen was substituted for hydrogen, the strongest lines of the green flutings were seen when the spark without jar was first passed at atmospheric pressure, probably from hydrogen occluded, as it usually is, in the magnesium electrodes. As the pressure was increased they speedily disappeared entirely and were not again seen either at high or low pressures.

With carbonic oxide the same thing occurred as with nitrogen; but in this gas the flutings due to the oxide of magnesium (wave-length 4930 to 5000) were, for a time, very well seen.

Ciamician ("*Sitzungsber. Akad. Wissensch.*," Wein, 1880, p. 437) has described a spectrum of magnesium of the first order ("Plücker's Nomenclature") obtained by taking sparks from an induction coil, without a jar, between magnesium electrodes in an atmosphere of hydrogen. He gives a figure to a scale of this spectrum, but it is not to a scale of wave-lengths, so that exact comparison of his observations with ours is difficult. The least refrangible set of flutings in his figure corresponds very well with that we have described in the yellowish green. The next set, in the green, in his figure does not, however, correspond exactly with ours; it begins nearer to *b* than we have observed, and consists of four flutings, whereas we observed but two in this set. It looks as if, in his figure, the magnesium-hydrogen spectrum were superposed upon the hydrocarbon spectrum in this region. Further, he gives a third more refrangible set of flutings which we have not observed at all in the magnesium-hydrogen spectrum. This third set of flutings, as drawn in his figure, appears to be somewhat more refrangible than the set due to the oxide, and occupies nearly the place of the blue hydrocarbon series, but a passage in the text, in which he says that the magnesium spectrum of the second order might, without measurement, easily be taken to be identical with that of carbon, almost negatives the supposition that this set of flutings is the blue hydrocarbon set and mistaken for a magnesium spectrum of the first order. To whatever it may be due, we have not seen anything like it under the circumstances described by him, though our observations on the spark spectrum of magnesium in hydrogen have now been repeated with all the variations of circumstance which we could devise.

Mr. Lockyer states (*loc. cit.*) that none of the lines of magnesium, special to the flame spectrum, are visible in the spectrum of the chloride, either when flame or spark is employed. But we find that when the spark is taken between platinum points, from a solution of the chloride of magnesium, in a tube such as those used by Delachanal and Mermet, the line at wave-length 5210 can frequently be seen in it when the tube is filled with air, and that if the tube be filled with hydrogen the green flutings of magnesium-hydrogen are persistent and strong,

Repeated observations have confirmed our previous statements as to the facility with which the magnesium-hydrogen spectrum can be produced in the arc by the help of a current of the gas. In a magnesia crucible, by regulating the current of hydrogen, the flutings can be easily obtained either bright or reversed.

Comparison of the Spectra.

When we compare the spectra of magnesium in the flame, arc, and spark, we observe that the most persistent line is that at wave-length 2850, which is also the strongest in the flame and arc, and one of the strongest in the spark. The intensity of the radiation of magnesium at this wave-length is witnessed by the fact that this line is always reversed in the flame as well as in the arc when metallic magnesium is introduced into it, and in the spark between magnesium electrodes when a Leyden jar is used. It is equally remarkable for its power of expansion. In the flame it is a broad band, and equally so in the arc when magnesium is freshly introduced, but fines down to a narrow line as the metal evaporates.

Almost equal in persistence are the series of triplets. Only the least refrangible pair of these triplets are seen in the flame, another pair are seen in the spark, but the complete series is only seen in the arc. We regard the triplets as a series of harmonics, and to account for the whole series being seen only in the arc we must look to some other cause than the temperature. This will probably be found in the greater mass of the incandescent matter contained in the crucible in which the arc was observed.

The blue line of the flame at wave-length 4570 is well seen in the arc, and is easily reversed, but is always a sharp line, increased in brightness but not sensibly expanded by putting magnesium into the crucible. In the spark, at atmospheric pressure, it is only seen close to the pole or crossing the field in occasional flashes; but seems to come out more decidedly at rather higher pressures, at least in hydrogen.

The series of bands near L, well developed in the flame, but not seen at all in the arc or spark, look very much like the spectrum of a compound, but we have not been able to trace them to any particular combination. Sparks in air, nitrogen, and hydrogen have alike failed to produce them.

The very strong, rather diffuse triplet at M, with which they end so closely, resembles in general character the other magnesium triplets, that it may well be connected with that constitution of the magnesium particle which gives rise to the triple sets of vibrations in other cases, but, if so, its presence in the flame alone is not easily explained.

The occurrence of this triplet in the ultra-violet, and of the remarkable series of bands associated with it, as well as the extraordinary intensity of the still more refrangible line at wave-length 2850, which is strongly reversed in the spectrum of the flame, corroborates what the discovery of the ultra-violet spectrum of water had revealed, that substances at the temperatures of flames while giving in the less refrangible part of the spectrum more or less continuous radiation, may still give, in the regions of shorter wave-length, highly discontinuous spectra, such as have formerly been deemed characteristic of the highest temperatures. This subject we will not discuss further at present, but simply remark what we have stated formerly, that "it opens up questions as to the enormous power for radiation of short wave-length of gaseous bodies at the comparatively low

temperature of flame with regard to which we are accumulating facts."

In the arc and spark, but not in the flame, we have next a very striking group of two very strong lines at wave-lengths about 2801 and 2794, and a quintuple group of strong but sharp lines above them. The former are usually reversed in the spark with jar, and all are reversed in the arc when much magnesium is present. There are also several single lines in the visible part of the spectrum common to the arc and spark. All of these may be lines developed by the high temperature of the arc and spark. Two blue lines in the arc have not been traced in the spark, but their non-appearance may be due to the same cause as that above suggested for the non-appearance of the higher triplets, the smallness of the incandescent mass in the spark.

A pair of lines in the arc near U appear to be represented in the spark by an equally strong, or stronger, pair near but not identical in position. The possibility of such a shift, affecting these two lines only in the whole spectrum and affecting them unequally, must in the present state of our knowledge be very much a matter of speculation. Perhaps sufficient attention has not hitherto been directed to the probability of vibrations being set up directly by the electric discharge independently of the secondary action of elevation of temperature. Some of the observations above described, and many others well known, indicate a selective action by which an electric discharge lights up certain kinds of matter in its path to the exclusion of others; and it is possible that in the case of vibrations which are not those most easily assumed by the particles of magnesium, the character of the impulse may slightly affect the period of vibration. The fact that, so far as observations go, the shift in the case of this pair of magnesium lines is definite and constant, militates against the supposition suggested. On the other hand, the ghost-like pairs of lines, observed in the spark below the triple near L, suggest the idea that some of the particles have their tones flattened by some such cause.

The strong pair at wave-length 2801, 2794, are accompanied in the spark, but not in the arc, by a much feebler, slightly more refrangible pair, but these have not the diffused ghost-like character of those just alluded to.

These lines are phenomena of the high potential discharge in which particles are torn off the electrodes with great violence, and may well be thrown into a state of vibration which they will not assume by mere elevation of temperature.

There are two lines in the spark besides the well-known line at wave-length 4481 which have not been observed in the arc, but they are feeble and would be insignificant if it were not the fact that they, as well as wave-length 4481, are short lines seen generally only about the poles, appear to be present in the solar spectrum. In the sun we seem to have all the lines common to the flame, arc, and spark (unless the line given in Ångström's map at 4570·9 be not identical as we believe it to be with the magnesium line), and possibly, judging by Draper's photograph, the strong triplet of the flame at M; but one line common to the arc and spark at wave-length 4703 does not appear in the sun, at least in Ångström's map. It is hard to account for its absence, since it is a bright and conspicuous line in the arc, and usually seen, though less prominent, in the spark. We have noticed, however, that when the spark is taken in hydrogen, the line at wave-length 4570 appears stronger than that at wave-length 4703, while the reverse is the case when the atmosphere is nitrogen. It is possible then that the atmosphere may, besides the resistance it offers to the discharge, in some degree affect the vibrations of the metallic particles.

When we have made all the simplifications that we can by eliminating, as we hope we have done satisfactorily, the hydrogen-magnesium flutings, and by supposing the whole series of triplets to be harmonically related, and possibly some of the single lines also to be similarly related, we have still the fact that the chemical atoms of magnesium are either themselves capable of taking up a great variety of vibrations, or are capable by mutual action on each other, or on particles of matter of other kind, of giving rise to a great variety of vibrations of the luminiferous ether; and to trace satisfactorily the precise connexion between the occurrence of the various vibrations and the circumstances under which they occur, will require yet an extended series of observations.

ON THE DETERMINATION OF POTASSIUM AS POTASSIUM PLATINO-CHLORIDE.

By ROBERT R. TATLOCK, F.R.S.E., F.I.C., F.C.S.

On May 1, 1880,—that is, more than a year ago—I sent a circular on the above subject to all the manufacturers of potash salts in Germany, so far as I could discover them. This is the "circular" referred to by Drs. Zuckschwerdt and West in their communication on the above subject, which appeared in the Chemical News, vol. xliii., p. 251. For reasons, however, which will presently appear, these gentlemen have not produced the circular, but have merely quoted from it a portion to suit their own purposes, and which is the least essential.

The following is a fair copy of the circular, which, it will be seen, is a challenge to the German manufacturers. Up to the present moment that challenge, for obvious reasons, remains unaccepted:—

City Analysts' Laboratory,
138, Bath Street, Glasgow.
1st May, 1880,

"To the Manufacturers of Potash Salts in Germany.

"Gentlemen,—You are aware that for many years past I have had occasion to analyse samples of Muriate of Potash and other Potash Salts, representing shipments to consumers and merchants in this country, and that in very many instances dissatisfaction has been expressed on account of differences between my analyses and those of German chemists, and which, it is represented, arise from a slight modification of the platinum process for the estimation of Potassium which I have found it necessary to adopt, when Sodium Salts are present, in order to get accurate results. I have endeavoured on all occasions to satisfy manufacturers and others who objected to my method of analysis, that it did not give results lower than the truth, and I have frequently furnished them with a written description of it, in order that they might examine it for themselves, but, I regret to say, without success; and as I am no longer able to continue detailed correspondence on the subject, I beg hereby to make them the following offer, jointly and separately, with the object of having that point settled once for all:—

"That Professor Fresenius, of Wiesbaden, be requested to make three test experiments on my process, using *Pure* Chloride of Potassium, and that he grant a certificate stating the results separately, and also the mean.

"That in the event of the mean result coming out lower than the truth, I shall agree to add the difference in all future analyses made by me.

"That the experiments be made by Professor Fresenius, or his assistant, in his laboratory at Wiesbaden, in my presence and in that of a representative chosen by the German manufacturers, but neither of us to have anything to do with the manipulation.

"That Professor Fresenius supply all the materials and apparatus, and that he be the sole arbiter on all points that cannot be tested by experiment.

"That under any circumstances I charge nothing for my time: but that, in the event of the mean

result coming out above 99·5 per cent, the manufacturers will pay my travelling and hotel expenses from and back to Glasgow; and that, whatever the result may be, the manufacturers will pay Fresenius's fees.

"The following is my process herein referred to:—Dissolve 35 grms. of the sample in water, filter if necessary, and make up the bulk to 500 c.c. Deliver 10 c.c. of the solution into a small porcelain basin, add 20 c.c. of water, stir, then add 30 c.c. of a solution of platinic chloride containing 7 grms. of metallic platinum in every 100 c.c. Evaporate on water-bath, but not to perfect dryness, add a few drops of water and evaporate again, remove the basin and stir the ppt. well with 2 c.c. of the platinum solution, then wash the ppt. on the filter with 1 c.c. more. Now wash the basin and filter and contents with the smallest possible quantity of alcohol of 95 per cent. Dry filter containing the precipitate, on the water-bath, remove the precipitate, as completely as possible, into a small platinum capsule, dry at 100° C. and weigh. Ignite the filter with trace of adhering precipitate, weigh the residue of $Pt+2(KCl)$ which is left, calculate its weight to $2(KCl)PtCl_4$ and add the weight to that of the precipitate already obtained.

"I enclose an extra copy of this letter, and will thank you to make my offer as widely known as possible.

"I am, Gentlemen,

"Your obedient Servant,

"*(Signed)* Robert R. Tatlock."

In place of accepting this challenge—which every unbiassed person will admit is fairness itself—our German friends have followed the ingenious, but to us rather unsatisfactory, plan of getting their own chemists to make experiments privately upon my method, and to tell us what results they got in this way, when nobody was present to verify them, and affect to be simple enough to suppose that we shall credit these results in the face of so much evidence to the contrary, obtained by eminent chemists, both of their own country and this.

It would be be a very easy matter for me to come forward, as our two doctors have done, with some figures written on a sheet of paper, and state that these were results which I had obtained privately, and that they entirely confuted theirs; but as I am, like them, an interested party in this discussion, I quote no results of my own, but only those of chemists of repute, who have no interest one way or another.

The experiments made by the two doctors go to show that my method, in their hands, gives on an average result 0·35 per cent of chloride of potassium too low. Let us see what Fresenius's practice and opinion are as regards this. Some time ago a portion of a carefully mixed and pounded sample of muriate of potash—of which I had made previously a complete analysis—was forwarded by a well-known firm to Fresenius, unknown to me, with the request that he would spare no pains to arrive at the truth regarding the relative proportion of potassium and sodium salts which it contained. The following are the results of the respective analyses:—

	Tatlock. Per cent.	Fresenius. Per cent.
Chloride of potassium	88·50	88·86
Sulphate of potash	0·13	—
Chloride of sodium	8·46	8·39
Sulphate of lime	0·18	0 22
Chloride of magnesium	0·50	0·47
Insoluble	0·23	0·23
Water	1·80	1·83
	99·80	100·00
Potash	55·97	56·10
Equal to chloride of potassium	88·60	88·86

With reference to these results and my method, Fresenius wrote at the same time as follows:—"He makes the chloride of potassium 0·21 per cent lower than I. The discrepancy, however, will scarcely ever be greater." Here, then, is a guarantee from Fresenius himself, not only that my analysis, but that my method, was correct within 0·21 per cent; and a difference such as this is not considered of much importance among German chemists who are authorities on potash analysis, for Dr. G. L. Ulex, of Hamburg, in giving an account of his process, states that he obtains results reliable within 0·2 per cent, and adds with regard to his method—"That although simple, it requires to be worked carefully, otherwise serious mistakes may be made."

It would appear, further, that Fresenius, notwithstanding his *own results* and *opinion*, has given the two doctors a certificate to the effect that their experiments were carefully conducted, although he did not see them made, but merely *read the essay* in which their results were stated.

In addition to this we have the experiments made by the Committee of the British Association for the Advancement of Science, appointed to report "On the Methods Employed in the Estimation of Potash." I did not suggest the formation of that Committee, was not a member of it, and had nothing to do with its work. It consisted of Prof. Dewar, of the Royal Institution, London; Mr. A. H. Allen, Public Analyst, Sheffield; and Mr. E. C. C. Stanford, who is a manufacturer of potash salts.

The following are the experiments referred to, and were made by the Committee upon mixtures of pure potassium and sodium chlorides by my process:—

Comparison of the Actual Composition of Mixtures of Potassium and Sodium Chlorides with the results obtained.

Large Excess of Platinum.

KCl taken. Per cent.	NaCl taken. Per cent.	KCl obtained. Per cent.	Error.
82	18	82·09	+0·09
82	18	82·15	+0·15
82	18	82·12	+0·12
82	18	82·20	+0·20
50	50	49·67	−0·33
50	50	49·60	−0·40
50	50	49·80	−0·20
50	50	49·72	−0·28
50	50	49·87	−0·14
50	50	49·91	−0·09
50	50	49·98	−0·02
67	33	66·63	−0·37
67	33	66·77	−0·23
	Average		−0·11

It will thus be seen that the average error of thirteen experiments is 0·11 per cent, a result which I think all will admit is sufficiently near the truth, and these trials were made with a large excess of chloride of platinum.

The buyers and consumers of German muriate of potash here will now have no difficulty in perceiving how matters stand, and will think twice before they will accept German analyses showing 100 per cent between chloride of potassium and water *alone* in an article like commercial muriate of potash, which is sure to contain, in addition, chloride of sodium, sulphate of lime, chloride of magnesium, and insoluble matter, for which, however, many German analyses leave no room.

I have only further to remark that Dr. Zuchschwerdt and West's experiments, undertaken with the object of showing the non-interference of sodium salts by their process, where *none were present*, has clearly no bearing on the question.

Action of Light upon Silver Bromide.—G. Noel.—Silver bromide preserves the molecular modification impressed upon it by the chemical spectrum, so much the longer as its sensibility is greater.—*Comptes Rendus.*

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,
Member of the American Society of Civil Engineers.

(Continued from p. 254.)

Returning from the long digression of comparison of American with foreign requirements, to the consideration of absolute requirements and practical demands. The following has been established by the previous argument, that for the support of life, each person must have one-third to one-half a cubic foot of fresh air each minute. That for the conservation of temperature to the point of comfort, each person supplied with air at 70 degrees in its usual condition of summer air in America, must have four to four and a half cubic feet per minute. That to maintain the freshness of air in a continuously occupied room, so that it shall be pure to the sense of smell—a condition which is found to correspond generally to the presence of 8 parts of carbonic acid to each 10,000 parts of air—about thirty cubic feet of air per person per minute is requisite. It has been shown also how audience halls, without systematic ventilation, or at best supplied with very limited quantities of air, are, if of adequate cubic content in comparison to the number of persons present, and if occupied only in short sessions, and if judiciously supplied with fresh air between the sessions, relatively healthy, comfortable, and acceptable to the persons attending them. The point for enquiry which now follows is—what is the practical limit for quantity of air to be *systematically supplied?*

The proposition before established, that the cubic contents of the hall can be reckoned as part of the supply itself, by taking the number of minutes the hall is occupied by a certain number of persons, becomes now of importance in fixing the limit for momentary supply, when the average length of session can be assumed. But this is really of less importance than would appear from mere statement. On the whole, in audience halls, the cubic capacity per sitter will be found to be from 200 to 300 cubic feet, or only 6 to 10 minutes supply of air to each person, where the final relative purity is to correspond to a supposed regular supply of 30 cubic feet per minute. If this cubic capacity is to be taken in addition to any regular supply for a given length of time, then if 100 minutes (1 hour 40 minutes) are taken as the length of the session, two to three cubic feet of air per minute becomes available as an addition to whatever is supplied.

The practical difficulties in ventilation of halls which effect the quantity of air to be supplied are those of introduction and of distribution. The difficulty of introduction is perhaps the most serious trouble. Dr. Reid's proposition for a perforated flooring would seem to present a satisfactory solution, and it is questionable if justice has been done the reputation of the scheme by the public, for the method continues in operation to this day, with twenty-four years' service at the Houses of Parliament; although embarrassed in its action by singularly unmechanical and inefficient apparatus for warming and supplying the air. It cannot be claimed, however, that the construction of a sub-hall for equalisation of pressure will meet the approval of architects or builders in future, and Dr. Reid's effort will probably remain as an example rather than be accepted as a model. But Dr. Reid was for a whole lifetime of arduous labour an intelligent and careful observer of the requirements for the ventilation of audience halls. As the result of his study he concluded, and he expressly states his conclusion as with diffidence, that 10 cubic feet of air to each individual would suffice to properly ventilate a hall. His great effort was to arrange to supply this quantity in such way as should be at once effective and imperceptible to an audience. Much of his want of success laid in the imperfections of his mechanisms, in the coils or heating surfaces, and in the fans or means of impelling air. Some of it laid in the effort to regulate the audience as well as the ventilation. His lifelong difficulty was found in the establishment of local currents engendered by his imperfect apparatus, and from the sensation of cold which such currents produce.

Systematic supply involves arrangements of ducts and passages by which the outer air, from some chosen point, shall be transported to certain desirable mouths of delivery or inlet registers. The dimensions to be given these ducts or passages are absolute and positive ones, when the quantity of air to be moved shall have been established by the number of persons and their supply, and when the velocity of movement of air is determined or accepted. The velocity of movement is limited on the one hand by the motive power applied to impel or effect it; that is, by the expenditure of force demanded; which means in the end, whether impulse by fans and engines, or a draft from a heated flue be used, expenditure of fuel, and, on the other hand, by practical dimensions accepted in construction of the ducts or passages.

In figures, ducts for forced ventilation must suppose currents of from 600 to 1200 feet per minute, with some allowance of sectional area for branch ducts, which shall admit a less velocity of flow through them; while ducts for currents induced by exhaust shafts, or produced by the entry of heated air, at the usual temperature of steam heated currents, will have a usual velocity of from 150 to 300 feet per minute—sometimes under favourable conditions for making a draft, rising to 300 or even to 600 feet per minute.

Systematic supply involves also the heating of air to be supplied, in an extreme case, from 5 degrees to 10 degrees below zero up to perhaps 75 degrees, in such extreme case of cold weather. Ventilation is not attained except at cost for fuel, and a reasonable expenditure in this regard will meet approval when restricting the amount of ventilation to the necessities for health. The heat *will* in all cases be that of comfort or the *system* will be discarded.

Finally, the writer has sought with diligence and study to determine from irrefragable data the exact quantity of fresh air that should be supplied to each person of an audience per minute, and he now finds himself compelled to admit that no such data exists. That the quantity must be taken to have an arbitrary value founded on economic and structural, as well as upon medical and chemical, considerations; that this value must have its authority from its general acceptation by the community or by its general acceptance by investigators, who will have considered the question from all points.

It would seem that for audience halls occupied for sessions not exceeding two or three hours' duration, Dr. Reid's value of 10 cubic feet of air per minute is all that should be arranged for when planning such halls—all that can be judiciously urged in the accomplishment of ventilation in view of the cost in fuel and apparatus, quite sufficient to meet the physiological issue, and so large that it ought to be accepted from the medical point of view. This quantity might be referred to the maximum seating or holding capacity of the room to which it should be applied, when its partial occupancy would go towards increasing the general supply. And it should be referred to the coldest weather heating-power of the accompanying heating apparatus, so that in case of emergency of lengthened sessions in milder weather and in hot weather the quantity could be materially exceeded. When a forced ventilation by means of a fan is adopted, the flues and passages should refer to a winter ventilation at half speed of the summer one, and the quantity of summer ventilation would then become 20 cubic feet per person per minute; an amount of ventilation which, with open doors and windows, would, if the ventilating currents are suitably distributed amongst the audience, prove ample to give all the comfort possible to a crowd gathered in hot weather.

For audience halls in legislative buildings there is a propriety in adhering to the larger quantity of air which

* A Paper presented to the American Society of Civil Engineers, January 26, 1881.

has been mentioned as needful to preserve the sensation of pure air to the smell in continuously occupied rooms—to wit, 30 cubic feet of air per person per minute. As before, this quantity should be referred to the maximum attendance in any hall, and the capacity of the heating apparatus be referred to the coldest weather for such quantity, so that the forced ventilation should be adequate to give a double supply in mid-summer.

In the mind of the writer there can be no question whatever as to the direction of ventilation in a hall. A man lives in an ascending current of air—he is enclosed in one. In a crowd, without ventilation, a circulation takes place: in some way the roll of air which rises above one's head is replaced by cooler air sucked in sideways at the feet, or downwards, between the persons who form the crowd. If fresh air can be, and is, introduced imperceptibly at the floor near the person who needs it, the rising current supplies, nearly unmixed by diffusion, the air for respiration, while the vitiated air is swept upwards with the advantage of its levity as well as of the current of supply. A downward system of ventilation, on the other hand, where the air is supposed to be abstracted at the floor, near to the individual, supposes a thorough admixture, mechanically, of the respired and vitiated air with the descending sheet of fresh air. Within any hall where the air enters at the top there could scarcely exist any fresh air whatever, while the degree of vitiation would increase downwards, until the occupants of the hall would breathe and live in the vilest air possible for any given supply of fresh air.

There is also another matter to be thought of in ventilation of halls—the ventilation of the gas-lights, and besides this ventilation, the removal of the heat they generate. The ordinary gas-burner consumes 4½ cubic feet of gas per hour. Each burner may be taken to demand 2700 cubic feet of gas per hour, or 45 cubic feet of air per minute, when the temperature of the gases of combustion, including the 45 cubic feet of air, becomes, for open burners, as high as 99 degrees, and for Argand burners possibly as high as 128 degrees. In an upward ventilation the gas-lights present little difficulty, as the air for ventilation of the persons composing an audience will commonly exceed in quantity the greatest requirements for gas-burning. The vitiations arising from gas-lights are very objectionable when the attempt to introduce air strictly at the ceiling is made. The figures given here as to the requirements of gas-lights will allow provision to be made for them in arranging the ventilation of halls. The radiation of heat from gas-lights of a brilliantly lighted room becomes not only an important addition to the heat of the air, but also to the heat of the occupants of the room, independent of its temperature in some degree. This effect of gas-light is sufficient to reduce the desirable average temperature of a gas-lighted room some two to five degrees, and the necessary temperature of admitted air should fall off in like degree. No amount of ventilation will make it comfortable to sit near the great chandelier.

It is a source of great satisfaction to know that the electric light has reached that point of development where it has become available for lighting audience halls. The practicability of electric lighting at present is found in the production of large quantities of light. As the introduction of gas-light led to the use of much greater illuminating power than was obtainable by candle lighting, however numerous and sparkling the candle-lights may have been displayed from reflecting scones or chandeliers hung with lustres in old times, so the electric light also overpowers the gas light wherever substituted to much the same extent. The electric light is the nearest possible to the natural one of the sun. Properly arranged, to avoid distinct shadows, the correspondence to a carefully shaded room with ample midday light can be secured. Lighted from above, a complete avoidance of objectionable glare can be effected. Colours will have natural tints and values, and the gratification of our most delicate sense is not the least of promise in the perfection of electric lighting.

The vitiation of air by the electric light, arising from the slow combustion of the carbon, is too insignificant to form any element in considering the ventilation. For an equal quantity of light, there is generally seven hundred times as much carbonic acid in coal-gas lighting as in electric lighting. There is a small amount of vitiation from the electric light in the form of nitric or nitrous vapours, which may or may not accompany coal-gas burning to equal extent where equality of light-giving effect is made the standard of comparison. But this quantity of vitiation is also utterly harmless in the volume of air demanded for ventilation of the number of persons who are to derive their light from any given electric source. The heat effect of electric lighting is as favourable to the ventilation and comfort of audience halls as any other advantage presented. Thus, the same light-producing capacity gives thirty-four times as much heat for gas lighting as for electric lighting with equivalent light values, as the most unfavourable showing of the electric system, supposing all the force expended in the electric arc is transformed into heat. Furthermore, the superior safety of the electric light, as regards danger from fire, is not the least of its recommendations when enumerating advantages. At the present time the cost of electric lighting, with liberal allowance for use and deterioration of apparatus, is about one-half that of gas lighting, when the same quantity of light is supplied; but in view of the superior lighting usually practised when the electric system is introduced, the two methods approximate to the same cost generally.

Resuming the discussion of ventilation again. It must not be accepted from the foregoing remarks on downward ventilation that the removal of air at the floor of a hall is wholly impracticable. In rooms of limited floor area, like school rooms, an arrangement for supply and removal of air in conformity with the great natural circulation which occurs in all heated rooms, is likely to prove successful in those conditions of the weather which demand warm rooms. And as has been shown in our climate, there is but about one month in any year in which closed windows are desirable, *without an attendant supply of heat to the room*, it follows that such school rooms may be effectively ventilated during the eight months when our temperatures vary from zero to 40 or 50 degrees, that is for seven-eighths of the time when windows are closed. By judicious manipulation of windows and of eduction flues and their registers, the ventilation during the one month of closed windows without fire may be ameliorated, if not made altogether efficient.

Again, in churches and lecture rooms, where the economy of apparatus and of operating is esteemed superior to ample but expensive ventilation, the systematic provision and removal of much smaller quantities of air than have here been shown needful for desirable purity may accomplish much improvement in the direction of relative purity. The habitual method of warming a church building in America is by means of several hot-air furnaces, placed in the cellars underneath, as sources of heat, these furnaces having usurped the functions of the close stoves, with long lines of smoke-pipes, which were formerly a peculiar feature of the "meeting-houses" of our fathers. The furnaces have just about the same heating capacity, and the distribution and circulation of the heating currents within the walls of the church is effected in much the same way. When actively employed in warming the church by means of furnaces there is a supply of fresh heated air, considerable perhaps in itself, but inconsiderable, at its largest quantity, to the wants of ventilation of the numbers present. The control of temperature of the heating currents is very limited, the lowest temperature being commonly about 180 degrees, while the highest, often demanded in the coldest weather, rises to quite 300 degrees, and sometimes above this point; and the control of warmth in the church itself is obtained by closing or opening—registering off—the hot air current. In ordinary cases the registers are shut soon after the commencement of any session, and if the room be well filled, the heat of the persons present (especially at evening meetings, where gas-lights increase

this heat) causes it to become over-heated long before the end of the hour, or hour and a half, of usual session.

The equilibrium of temperature in such a room is established solely by the cooling effects of the walls or windows, downwards along which there falls a sheet of cooled air (augmented in cold at the windows by leakages inwards at the bottom of the same), a sheet which flows inwards towards the register openings, and is directed upwards with the flow from them; or when the register is closed off, the sheet forms part of the current of personal origin rising in the middle of the room. This roll of circulation goes on continually, and at some degree of elevation of temperature at the top of the room, the lower strata reaching to the height of above a gallery sometimes will be found to have attained some uniformity of heat. In fact, when filled with heat, as the furnace constructors denominate it, there will, in a church building of 35 to 45 feet in height, be less than 10 degrees difference between the floor level temperature of air and that taken 20 to 25 feet above such level. No large ventilating shaft can be taken from the upper part of such a room. Even the small opening to remove the gases of combustion of a chandelier disturbs the circulation of heat and intensifies the cold descending currents near the window, besides accelerating the leaks of cold air at the cracks; so that the ventilation of churches thus heated is practically limited to what leaks *out* of heated air, at or near the tops of windows, and what leaks *in* of cold air at or near the bottom of the same. A systematic leakage, which on windy days is modified by all leaks *in* at the windward windows, and all leaks *out* at the leeward ones. Now a kind of semi-ventilation of a church thus warmed and arranged can be effected by removal of air, at or near the floor, by means of ducts connected to an exhaust shaft; all of which will become operative if the currents from the hot air registers have been augmented to meet the requirement of air, by tempering the heated currents with direct currents of cold air, to desirable heat and quantity. Here it is seen that a downward ventilation, under conditions, may effect a good purpose to a certain extent.

It will not be attempted at this time to argue fully the advantages of the method of supplying air for ventilation by impulse by mechanical means—the superiority of forced ventilation, as it is called. This mooted question will be found to have been discussed, argued, and combatted on all sides, in numerous publications; but the conclusion of all is, that if air is wanted, in any particular place at any particular time, it must be put there, not allowed to go. Other methods will give results at certain times or seasons, or under certain conditions. One method will work perfectly, with certain differences of internal and external temperatures, while another method succeeds only when other differences exist. One method reaches to relative success whenever a wind can render a cowl efficient. Another method remains perfect as a system if no malicious person open a door or window. No other method than that of impelling air by direct means, with a fan, is equally independent of accidental natural conditions, equally efficient for a desired result, or equally controllable to suit the demands of those who are ventilated; which last requirement, it will be shown further on, is more essential than to meet their necessities.

(To be continued.)

Certain Substitution-Derivatives of Azo-benzol.—A. Calm and K. Heumann.—The authors examine the behaviour of para-dichlor-hydrazo-benzol with hydrochloric acid, the results of the reaction being para-dichlor-azo-benzol and para-chlor-aniline. Para-dibrom-hydrazo-benzol is decomposed in an analogous manner. On prolonged treatment with weak fuming sulphuric acid at 140° to 150° para-dichlor-azo-benzol is converted into mono-sulpho-para-dichlor-azo-benzolic acid. There is also a description of the nitro-derivatives of para-dichlor-azo- and azoxy-benzol.—*Berichte der Deutschen.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, June 11th, 1881.

Lord Rayleigh in the Chair.

New members—Mr. J. E. H. Gordon and Mr. J. E. Stead, E.I.C.

Prof. Fleming exhibited a new form of B.A. unit resistance coil, devised by him for experiments in the Cavendish laboratory, with a view to obviate the leakage in the older form due to condensed moisture on the paraffin insulating the electrodes, and also to facilitate the equalisation of the temperature of the coil with the medium it is placed in. For this purpose the wire is wound bare, each layer being insulated from the rest by ebonite fenders niched to receive the turns, and the coil is enclosed in a brass box, screwed together. This box is water-tight and may be soldered, or provided with an india-rubber washer between the two flanged halves which screw together.

Dr. Stone said he usually insulated the B.A. coil when plunging it in water, by putting it in a beaker of paraffin oil, which was immersed in turn in the water.

Prof. Ayrton pointed out the advisability of makers aiming rather at turning out exact resistances of any definite value than wasting time and increasing the cost of the coils by adjusting them to a given figure, such as 1 or 10 ohms.

Prof. W. Chandler Roberts read a paper "*On the Hardening and Tempering of Steel.*" He pointed out that few questions connected with the metallurgy of iron and steel are attracting more attention now than the relation between a metal and the gases it comes into contact with during manufacture. The carburisation of iron has long been of great interest, as shown by the work of Clouet at the end of last century, and that of Margueritte in 1865, who showed that though the conversion of iron into steel could be effected by contact with carbon even in the diamond form, it is nevertheless true that in the ordinary process carbonic acid plays a considerable part which had been overlooked. Graham's 1867 paper on the occlusion of gases by metals gave point to Margueritte's work by showing that carbonic oxide can penetrate to the centre of a mass of iron. It is introduced, in fact, at a comparatively low temperature, while a high temperature is necessary to enable the metal to appropriate the carbon and become steel. Metallurgists are now carefully investigating the effect of occluded gases in iron and steel. Prof. Roberts considered the point recently raised as to whether the hardening and tempering of steel might not be influenced by the occlusion or expulsion of gas. He described experiments by which he proves that as steel hardens when rapidly cooled *in vacuo*, gases could not play any part in the tempering. He also dwelt on the precautions necessary to keep the metal in the experiment free from occluded gas. He then showed that Bergman (to whom we owe our knowledge that the difference between wrought-iron and steel depends on the carbon in the latter) showed in 1781 that fixed air could give up its carbon to iron, and he concluded by showing that Reaumur, so long ago as 1722, actually employed the Toricellian vacuum in experiments on the tempering of metal, the metal being placed red-hot in a highly rarefied atmosphere. Reaumur also had a clear view of the effect a gas might have on the physical properties of a metal—a point of great interest to physicists in general.

Prof. Hughes expressed the opinion that temper was not due to absorption of hydrogen, but to the absorption of carbon in the iron.

Mr. Stroh found that an electrically fused steel contact was glass hard.

Prof. Guthrie exhibited a steel chain which he had beautifully blackened by dipping in fused nitre. The

skin might be useful in the arts, and was perhaps analogous to that produced by Barff's process.

Lord Rayleigh, Mr. Walenn, Mr. Lecky, Dr. Coffin, Prof. Ayrton, and others continued the discussion.

Mr. GRANT then read a paper on Curves of Electromagnetic Induction, which he had traced out by means of primary and secondary coils sliding on frames, so as to take different positions with respect to one another. The paper was illustrated by experiments and diagrams.

Prof. REINOLD then read portions of a paper by Prof. S. P. THOMSON "*On the Opacity of Tourmaline Crystals.*" The optical and electric properties of these crystals are related, and Prof. THOMSON propounds an explanation of this connection based on the late Clerk-Maxwell's electromagnetic theory of light. The full paper will be published in the journal of the Society.

CORRESPONDENCE.

THE ESTIMATION OF PEROXIDE OF HYDROGEN.

To the Editor of the Chemical News.

SIR,—I regret that Mr. Em. Schöne has, in his recent communication to your journal, committed himself to statements against which I feel it necessary only to record an emphatic protest.

As, under the circumstances, I cannot continue the discussion with Mr. Schöne, permit me to add that I abide by every word I have written upon the subject in question, and am fully prepared to stand or fall by my investigations.—I am, &c.,

C. T. KINGZETT.

17, Landsdowne Road, Tottenham, N.,
June, 8, 1881.

THE BAROMETER PUMP.

To the Editor of the Chemical News.

SIR,—Mr. James Johnstone's patent of May, 1847, is granted for a contrivance which Mr. Johnstone calls in his patent a "barometer vacuum *pan*," and which he now calls, after an elapse of thirty-four years, a "barometer *pump*." It is a vacuum pan, to the bottom of which a long tube has been attached, closed at its lower end by a tap. By opening occasionally this tap the sugar solution previously concentrated in the vacuum pan is allowed to escape without the admittance of air into the vacuum pan—owing to the length of the discharge-tube. This tube is not intended to create, or help to create, the vacuum in which the solution of sugar was concentrated, but merely to maintain the vacuum, created in the ordinary way and fashion of 1847.

As Mr. Johnstone removes no air from his vacuum pan by means of his patent *tube-tap*, it appears (from the evidence he has furnished) that he is not the inventor of an exhauster or an air-pump of any kind. A *tube-tap*, moreover, is neither a barometer nor an air-pump, and a barometer pump (known long before 1847) does not belong to the class of air-pumps which Dr. Sprengel introduced in 1865.—I am, &c.,

C.

June 11, 1881.

THE BAROMETER PUMP.

To the Editor of the Chemical News.

SIR,—Mr. Johnstone appears to have applied the principle discovered by Torricelli in 1643, and developed by Pascal, just as Bunsen has applied the principle discovered by Sprengel, which is totally different from the Torricellian. Mr. Johnstone is totally wrong, and misses his way when he says Dr. Sprengel "*followed his footsteps*," for, in point of fact, the instrument Johnstone used is no *pump* at all, but merely a *running-off pipe* (*vide* CHEMICAL NEWS, vol. xxxix., p. 256, and vol. xl., p. 42). Down this "*barometer pipe*," as W. Johnstone himself terms it in the former letter, the sugar solution flows by its own weight. The principle Dr. Sprengel discovered is a new one, and constitutes a means of continuous exhaustion with a quite small and simple apparatus, but the Torricellian principle, on which Johnstone's apparatus depends, can never be in like manner applied. Thus, so far from Mr. Johnstone being the father of "*barometer pumps*," it merely comes to this, that he is the "*father*" of a *running-off pipe* of a special kind, though all will admit the application of the principle of the Torricellian barometer to the maintenance of his vacuum to be highly ingenious.—I am, &c.,

VERAX.

WOOD-GAS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xliii., p. 57, an abstract of a paper on wood-gas gave its composition as hydrogen 5·4 per cent, marsh-gas 44·1 per cent. The numbers should be reversed. I send a copy of the original paper read before the American Chemical Society.

By modifications in the process since that date, the yield of gas per cord of wood has been increased to nearly 80,000 cubic feet. The amount of carbon dioxide in the crude gas has been so reduced by these changes as to be only 5 per cent.—I am, &c.,

CHARLES A. DOREMUS.

Bellevue Hospital Medical College,
New York, May 28, 1881.

THE ESTIMATION OF PHOSPHORUS IN STEEL.

To the Editor of the Chemical News.

SIR,—Notwithstanding the skilful manner in which Mr. Arnold trails the red herring across the scent, I must decline his invitation. Mr. Arnold shifts his ground with each letter, and so, to render the point at issue between us plainer, I propose to recapitulate the steps of the controversy.

1. Mr. Arnold writes a paper which, if it means anything, is intended to prove that Eggertz's molybdic acid method of estimating phosphorus in steel, gives results below the truth. Mr. Arnold states, that complete precipitation can only be effected by boiling the solution, a plan which brings down excess of molybdic acid and necessitates re-solution in ammonia and conversion of the phosphorus into ammonio-magnesium phosphate, for the complete precipitation of which Mr. Arnold allows one hour.

2. I object that Mr. Arnold's failure to obtain accurate results by the molybdic acid method was due to his neglect of certain well-known precautions.

3. Mr. Arnold replies in effect; "Yes; Eggertz's method gives correct results, if the operator exercises proper care; but that is not possible in practice, and my method is quicker and gives accurate results."

4. I object that the method suggested by Mr. Arnold has been previously proposed by several other chemists, and that it presents the great disadvantage that only 13·9 milligrms. of magnesium pyrophosphate would be weighed instead of 234·9 of the yellow precipitate.

5. Mr. Arnold writes in his last letter, "the question is not which method gives the heavier precipitate, but which is the more accurate. The solubility of the pyrophosphate in the mother-liquid would make the results low, whereas they come out higher than the molybdate."

This is arguing in a circle. Mr. Arnold says Eggertz's method may be correct if properly managed. I cannot afford the time to attend to the conditions of accuracy,

and as I work it I get low results; that is, I get lower than those by the magnesia method.

Every chemist knows and has used the method of determining phosphorus described by Mr. Arnold, but few would have the boldness to assert that the precipitation of the ammonio-magnesium phosphate was complete in *one hour*, when the *total quantity* of phosphorus to be determined was only such as would yield 0·0139 grm. of pyrophosphate. Yet if a longer time be required for precipitation, where is Mr. Arnold's sole remaining position, —that the method is more *rapid* than that of Eggertz? What correction does Mr. Arnold make for the solubility of his magnesium precipitate in the mother-liquor?—I am, &c.,

PHOSPHORUS.

June 11, 1881.

PS. Would Mr. Arnold be surprised to hear that estimations of phosphorus by molybdic acid are constantly made in certain laboratories in less time than Mr. Arnold prescribes for the deposition of the magnesia precipitate?

[This correspondence must now cease, as far as our columns are concerned.—*Ed.* C.N.]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 19, May 9, 1881.

Diazo-Benzol Nitrate.—MM. Berthelot and Vieille.—A thermo-chemical examination of this compound which has been proposed as a substitute for the fulminates in the manufacture of detonators. It explodes if struck, rubbed, or heated above 90°, and even below this point it undergoes a gradual decomposition. It is gradually decomposed by the action of light, and is at once destroyed on contact with water, yielding nitrogen, phenol, and other products.

A New Derivative of Nicotine, obtained by the Action of Selenium.—A. Cahours and A. Etard.—The product obtained, into which the selenium does not enter, is a hydrocollidine, a limpid amber-coloured liquid, boiling at 205°, lighter than and insoluble in water, but soluble in alcohol, ether, and dilute acids.

Densities of Liquefied Oxygen, Hydrogen, and Nitrogen in Presence of a Liquid without Chemical Action upon these Simple Bodies.—L. Cailletet and P. Hautefeuille.—M. Pictet has drawn from the numerical data of his researches on the liquefaction of oxygen an approximate value for its density in the liquid state. The authors have made their observations upon liquefied carbonic acid, mixed respectively with liquefied oxygen, hydrogen, and nitrogen. The densities of these bodies when liquefied, taken at two temperatures, but at one and the same pressure, enable it to be established that their coefficients of expansion differ so little that the densities have the same respective proportion at 0° and at −23°. The densities have therefore been taken at temperatures and pressures at which these liquids are mutually comparable, and they render it possible to calculate the relations of the atomic volumes of these three bodies. These atomic volumes are 17 for oxygen, 30·3 for hydrogen, and 31·8 for nitrogen if we divide each of the atomic weights of these bodies (O = 16, H = 1, N = 14) by its density at −23°, *i.e.*, 0·89, 0·033, and 0·44. Oxygen, hydrogen, and nitrogen when gaseous, deviate very unequally from the law of Mariotte at the pressures employed in the authors' experiments (275 to 300 atmospheres), and there exist no longer, under these conditions, simple relations between the atomic weights of these gases and their densities. But if a change of the state of aggregation is determined by a reduction of temperature it is found that the atomic volume of a body is a datum showing a positive relation between its density and its equivalent weight. If, as M. Stas holds, we cannot rely upon a law of condition for the determination of the true relation of the atomic weights, the atomic volumes lose their importance. But the atomic volumes which the authors have calculated deserve attention, even from this point of view, as furnishing numbers which are sensibly equal when they are not doubles of the atomic volumes assigned to their isomorphs. The atomic volume of nitrogen at −23° is about double that of phosphorus; these volumes would be about equal if we took the atomic weight of phosphorus as 62·8. The atomic volume of hydrogen at −23° is a little more than double the atomic volume of magnesium to which M. Dumas has already compared hydrogen. If experiment shows that magnesium in the state of vapour has a density forty-eight times greater than that of hydrogen, the anomaly observed in the nitrogen group, both in the gaseous and the liquid state, and ascribed to the splitting up of the molecule of nitrogen, would be repeated with the same characters in the group of which hydrogen is the first term. The atomic volumes of liquefied oxygen, hydrogen, and nitrogen differ much, as might be expected, from those which have been deduced from the molecular volumes of compounds into which these elements enter. M. Kopp has given several atomic volumes for these bodies. His numerical determinations, combined with those which the authors have just completed, will render it possible to explain the correlative contractions of the principal compounds of these bodies, whether among themselves, or with those of the other elements which are known in the liquid or in the solid state.

Performance of Secondary Batteries.—E. Reynier.—The performance is 81 per 100 of the initial force.

Certain Actinometric Measurements made in the Alps in 1880.—P. Puiseux.—The observations show that the activity of vegetation is proportional to the actinometric degrees measured.

Action of Light upon Phosphorescent Bodies.—M. Clémandot.—The author maintains that phosphorescence is a purely physical phenomenon, due to a vibratory action exercised chiefly by the blue ray of light. He connects these phenomena of vibration in phosphorescent bodies with those which light occasions in organised bodies.

Action of Carbonic Acid upon Baryta and Strontia. F. M. Raoult.—Baryta and strontia absorb carbonic acid very eagerly and become incandescent, but as is the case with lime the neutral carbonate cannot be reproduced by direct synthesis.

Products of the Action of Phosphorus Perchloride upon Acroleine.—P. Van Romburgh.—The author has satisfied himself of the absence of dihydrochloric glycide among the products of the reaction.

Die Chemische Industrie. No. 11, November, 1880.

Causticising Soda Lyes.—Dr. K. W. Jurisch.—In causticising revolver black-ash lye 11·8 cwts. lime are required per ton: for hand-worked black-ash 10¾, and for so-called red liquor, which contains 40 parts of caustic, only 8·9 cwts. In practice these low theoretical numbers are rarely reached, and 12 cwts. lime are used in producing a ton of caustic soda at 70 per cent. If sufficient agitation is not kept up during the reaction a much larger excess of lime is required to ensure sufficient causticity. A lye of sp. gr. 1·100 is the strongest that can be causticised in the ordinary manner without loss in the shape of a compound of soda and lime. This compound is produced to a very small extent only if lyes of 1·16 to 1·18 sp. gr. are causticised at 140° to 145° according to E. W. Parnell's process. A very considerable saving in coal is thus effected.

Technical Chemical Notes.—Dr. G. Lunge.—1. Decomposition of Sodium Sulphate by Lime.—Tessie du Motay asserted that at a pressure of 2 to 20 atmospheres from 75 to 80 per cent of the sulphate could be decomposed. Recent experiments show that a tolerably complete decomposition is obtained only at high pressures and with such excessive dilution as to put a practical utilisation of the process out of the question.

2. Decomposition of Sodium Sulphate with Barium Carbonate.—Experiments made both with precipitated carbonate and with powdered witherite at a boiling heat without pressure, but with reflux of the evaporating water, show that an almost complete decomposition is effected. Of precipitated carbonate the quantity required is 1½ equivs. and of witherite at least 2 equivs.

3. Decomposition of Soda Saltpetre with Carbonate of Lime as proposed by Waly and Lieber.—Experiments prove that by the use of 2½ equivs. calcium carbonate, it is possible to convert the nitre entirely into caustic soda, and recover the greater part of the escaping nitric acid. The practical difficulty lies in the rapid destruction of the vessels.

4. Behaviour of Solutions of Chlorates when Heated.—Neither in the calcium nor the potassium salt does any loss of oxygen take place on boiling. Hence an addition of potassium or calcium chloride at the beginning of the process is not necessary, and there is no need for an anxious avoidance of a high temperature in later stages of the operation.

5. Preparation of Potassium Ferricyanide by means of Lead Peroxide.—The conversion is not practicable on Böttcher's method, when the solution is rendered strongly alkaline. It is necessary to follow Schœnbein's process, saturating the liberated alkali as fast as formed by the continuous introduction of a current of carbonic acid. The yield is good, the quality unexceptionable, and there are no green by-products.

6. Preparation of Benzoic Acid from Benzo-trichloride and Water.—The conversion is complete on boiling benzo-trichloride with water in a reflux-cohobator for four hours.—*Dingler's Polyt. Journal.*

No. 12, December, 1880.

A New Double Salt of Potassium and Magnesium Sulphate.—Dr. H. Precht.—The formula of the new salt is $KSO_4 2MgSO_4 H_2O$.

The Ultramarine Question.—K. Heumann.—The author criticises H. Endemann's constitution-formula for ultramarine, as given in the CHEMICAL NEWS, vol. xlii., p. 204, and pronounces it devoid of all scientific foundation.

Manufacture of Citric Acid.—J. Casteo.—The process is described at very considerable length.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 13, No. 11.

A New Cymol Occurring in Light Resin Oil.—W. Kelbe.—This compound is obtained on purifying light resin oil with soda-lye, and submitting it to fractionated distillation. It is a colourless, strongly refringent liquid, boiling between 173° and 175°. On oxidation with potassium permanganate it yields isophthalic acid. The author regards it as meta-iso-cymol.

The Formation of Hypo-xanthine from the Albumenoids.—G. Salomon.—Not adapted for useful abstraction.

Influence of the Access of Oxygen upon Fermentation.—A. Mayer.—The author finds that free oxygen has no perceptible direct influence upon fermentation. He observes that under circumstances not yet perfectly determined, organic acids and their salts have a very remarkable influence upon fermentation.

Suberic Acid of Oxidation.—F. Ganther and C. Hell.—A very complete account of the salts of this acid.

Constitution of *a*-Disulpho-toluolic Acid.—Peter Claesson and H. Berg.—In order to decide this question the authors prepared the isomeric toluol-mono-sulphonic acids.

Determination of the Extractive Matter in Wine.—E. A. Grete.—The irregularity in the results hitherto obtained is due to the volatility of glycerin at 100°. The author heats 10 c.c. of the sample in a small platinum capsule in order to expel carbonic acid, and adds 10 to 20 c.c. of accurately titrated baryta-water in order to neutralise the acids, and to fix the volatile matters as far as possible. The whole is then dried up on the water-bath, and afterwards evaporated in a drying-niche at 110°, till the weight becomes constant. 1. The quantity of the baryta solution required to neutralise the acids of the wine is found by direct titration. In the first place, for every molecule $Ba(OH_2)$ consumed BaH_2 must be deducted. 2. Another part of the c.c. of baryta solution added becomes converted into barium carbonate during the evaporation, and must be deducted. Its quantity is found by subtracting the c.c. of solution No. 1 and No. 3 from the total quantity which has been added. 3. The third part of the baryta solution remains in the weighed residue in the state of BaO combined with certain constituents of the extract. This quantity is determined by dissolving the extract in water, and carefully titrating the caustic baryta present. This is then deducted as No. 3 from the entire weight.

Process for the Preparation of Tartaric and Uvic Ether.—R. Anschütz and Amé Pictet.—The authors have obtained and examined dextro-tartaric dimethyl-ether, dextro-tartaric diethyl-ether, dextro-tartaric dinormal-propyl-ether, uvic dimethyl-ether, diacetyl-dextro-tartaric anhydride, dibenzoyl-dextro-tartaric anhydride, and diacetyl-uvic anhydride.

Certain Derivatives of Phenanthren.—R. Anschütz and J. von Siemenski.—An account of the bromo-phenanthren-mono-sulphates of potassium, silver, and barium.

Critique of Meyer's Method of Determining Vapour-Densities.—Otto Pettersson and G. Ekstrand.—The authors maintain that the accuracy of V. Meyer's method is not beyond doubt. They have made comparative determinations of the vapour-densities of a number of compounds by the methods of Meyer and of Dumas at exactly the same temperatures, and have found that the former process yielded invariably smaller and less mutually concordant results than that of Dumas, the latter of which agreed almost perfectly with the figures calculated by W. Gibbs in accordance with theory. They point out two sources of error in Meyer's process,—the condensation of air on the surface of the vessel of glass, porcelain, or platinum, in which the substance is enclosed, and the condensation of air in the substance itself, an error which cannot be compensated, since organic fluids absorb air in very different proportions.

Application of the Method of Dumas to the Examination of the Gaseous Condition of Anhydrous and Hydrated Formic and Acetic Acids.—Otto Pettersson and G. Ekstrand.—This paper cannot be intelligibly reproduced without the accompanying figures.

Photo-chemical Behaviour of Silver Bromide in Presence of Gelatin.—H. W. Vogel.—The author contrasts the behaviour of gelatin in presence of silver bromide with that of collodion.

Action of Bromine upon Dichlor-hydrine and the so-called Propyl-phycite.—A. Claus and R. Lindhorst.—In the action of bromine upon dichlor-hydrine the central carbon atoms are first oxidised to acetone, and that there is no formation of a body of the composition of the hypothetical brom-dichlor-hydrine from which a phycitoid compound might be derived.

Bromine Derivatives of Nicotin.—R. Laiblin.—The author has prepared and examined brom-nicotin,—

$$C_{10}H_{12}N_2Br_2.$$

MISCELLANEOUS.

Society of Chemical Industry.—We beg to call the especial attention of our readers to the approaching General Meeting of the Society of Chemical Industry, as announced in our advertising columns. Among the papers to be read, those on "Recent Legislation on Noxious Gases," and "The Patent-laws as Applied to Chemical Inventions," will have a claim on the serious attention of all persons engaged in chemical manufactures,—the more, as further legislation, in both directions, is imminent.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Arsenic from Tin Ore.—Can you inform me in what work or publication I can find the latest improvements in the process for obtaining commercial arsenic from tin ore, which contains 35 per cent of arsenic, and is, therefore, worth working for the arsenic itself? —A READER.

MEETINGS FOR THE WEEK.

WEDNESDAY, 22nd.—Geological, 8.
THURSDAY, 23rd.—Royal Society Club (Anniversary), 6.30.
FRIDAY, 24th.—Quekett, 8.
SATURDAY, 25th.—Physical, 3. "Apparatus for Lecture Experiments on Current Induction," W. Grant. "Results of Experiments with a Modification of Bunsen's Calorimeter," Prof. Balfour Stewart and W. Stroud.

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THE CHEMICAL NEWS.

Vol. XLIII. No. 1126.

ON A CURIOUS ACTINIC PHENOMENON.

By Dr. T. L. PHIPSON, F.C.S., &c.

Having seen a paragraph in several English and Foreign periodicals relating to a novel actinic phenomenon discovered by me some time ago, it will be, perhaps, expedient to publish all I know at present upon this singular occurrence. In the first place, it is necessary to state that the phenomenon in question was first noticed by my friend, Mr. Thos. Griffiths, F.C.S., who called my attention to it more than a year ago, and requested me to investigate the cause of it.

The first observation was that a gate post painted white by means of a new white pigment having a zinc basis appeared black all day and white all night, turning black again soon after sunrise, *et ainsi de suite* for any number of days.

The white pigment was prepared by precipitating a solution of sulphate of zinc by another of sulphide of barium, and its analysis gave me the following results:—

Loss by calcination	1·62
Sulphate of baryta	41·50
Sulphide of barium	1·02
Protoxide of iron	2·12
Oxide of zinc	16·30
Sulphide of zinc	37·44
Lead, arsenic, manganese, &c. ..	traces
	100·00

I found that when this white powder was spread upon a piece of paper and exposed to the direct rays of the sun, it became fawn coloured, brown, and finally a dark slate colour in the course of about twenty minutes. When in this state it was placed in darkness it became white again in 2½ to 3 hours' time.

The phenomenon was doubtless due to the use of sulphide of barium in the preparation of the pigment; for specimens made by another process in which no sulphide of barium is used did not show it at all.

The property possessed by sulphide of barium of becoming phosphorescent after insolation has been long known, but the explanation of this curious phenomenon is no further advanced now than when my little volume "Phosphorescence, &c.," appeared in 1862, unless the recent interesting electric experiments by Mr. Crookes, F.R.S., supply the key to the enigma.

In the present case, however, no phosphorescence is observed when the insolated pigment is carried into a dark place during the time it is undergoing colouration by the direct influence of the solar rays.

Another curious fact soon struck me, namely, that if a piece of glass were laid over the white pigment when exposed to the sun, it did not darken, however thin the glass might be: whilst the half of the specimen which remained uncovered took a very dark slate colour in about half-an-hour, that which was protected by the glass was nearly as white as at first, and it took from 4 to 8 hours' exposure to direct sunlight to give to this portion under the glass a very slight fawn-colour.

Of course these phenomena could not be due to any compound of silver; nevertheless, the specimens were tested for silver, and with great care, but without the slightest result. In fact, no actinic substance has been met with that will *darken in the sunshine, become white again in the dark, and will not darken under a sheet of ordinary window glass.* It was hinted that I was dealing with a new element (to be called "Actinium"); but the continuation of my experiments lead me to believe that the phenomena described above may probably be due to the presence of *sulphide of barium* and *protoxide of iron* in the specimens, rather than to some unknown metal.

I observed that the dark slate coloured product was immediately soluble in cold acetic acid (as sulphide of iron is); and if the dark colour be due to the production of sulphide of iron, the return of the pigment to its original white tint when placed in darkness for some hours, may be owing to the gradual oxidation of this sulphide of iron and consequent disappearance of the dark colour.

The baryta soluble in acid found in the analysis is calculated as sulphide, and the iron as protoxide (as it exists in the *proto* state), but the pigment may really contain some compound oxy-sulphide of zinc, iron, and barium, which has the property of turning black in the sunshine by the carrying of sulphur on to the iron during insolation; and the black sulphide disappearing by gradual oxidation when the stuff is placed in the dark would account for its reassuming its white tint.

I find also that a strong calcination, with free access of air, destroys, or considerably hinders, the production of the actinic phenomenon. I have also oberved that although the pigment will retain this property of darkening in the sunlight for more than a year, some specimens have lost this property in a few months; and a gate post painted white, after darkening, in the manner above mentioned, for the space of several days, will at last remain white.

All this points to the probability of the above explanation, but the matter is still under investigation.

OCCURRENCE OF A NODULE OF CHROMITE IN THE INTERIOR OF COMPACT METEORIC IRON FROM COHAHUILA.

By J. LAWRENCE SMITH, Louisville, Ky.

The masses of iron from Cohahuila that I have designated as the Eutcher Meteorites (to distinguish them from other meteorites from the same locality), have already afforded me several most interesting and novel results; among them, concretions of arragonite on the exterior (doubtless formed after their fall from surrounding conditions), and, more particularly, the new and interesting mineral, daubréelite, concreted in the interior of the troilite nodules that exist in this iron. A great number of sections have been cut, and daubréelite is always found with its well defined characteristics.

Recently I have had made two additional large sections. They have furnished, however, but few nodules. One of these was a well-defined symmetrically oval nodule, 17 m.m. by 12 m.m., its diameters situated 6 centimetres from the exterior surface, compact solid iron intervening between the surface and the nodule.

I was at once struck with its being different from any nodule I had yet observed in meteoric iron. There was no troilite in it, and although black it was not graphite; so that I supposed it might consist entirely of daubréelite. But its lustre was more vitreous than this last mineral. On examining carefully with a glass, I found in the black material a few particles of a translucent mineral, some particles of which were almost colourless, and one or two of a greenish hue (doubtless magnesian silicate); and, besides, there were a few specks of iron only traceable by the magnet.

The nodule was virtually a black granular mass. As stated, it was first taken for daubréelite. The smallest particle rubbed fine and fused with borax gave the intense green of chrome; but, to my surprise, when the powder was heated in nitric acid over a water-bath, not the slightest impression was made upon it, showing that it

was not daubréelite, which is soluble in nitric acid, leaving a dark green residue. Heating it in fused carbonate of soda in no way changed its insolubility in acids. These reactions convinced me that I had *chromite;* and on fusing 150 milligrms. of the finely pulverised mineral with ten times its weight of bisulphite of soda, it was thoroughly attacked, but not dissolved. On treating with water, and fusing the residue with carbonate of soda and nitre, proceeding with the analysis as is usual in the case of chromite, there was obtained—

Chromic oxide .. .. 62·71—Cr_2O_3
Ferrous oxide.. .. .. 33·83—FeO

the iron oxide being in the solution from the fused mass, after treatment with bisulphite of soda. The composition thus found is that of chromite. Traces of magnesia, cobalt, and silica were detected: the magnesia and silica doubtless came from the siliceous mineral already referred to, which is either enstatite or olivine.

The result of these observations, then, is to establish the existence of a new mineral concretion in the interior of meteoric iron: for while chromite has been known to be associated with meteorites, this is the first instance of its having been found embedded in this manner in the interior of meteoric iron. The fact thus increases the interest of the Butcher meteorites, which have furnished such beautiful and distinguishing concretions of two chrome minerals.

I should state that some of the particles of chromite, under the microscope and with very intense light, are feebly translucent, and have a dark reddish purple colour. This translucency of chromite has been observed by the Assistant of the Professor of Geology in the College of France. The name of this assistant I do not now recollect, and I cannot now place my hands on the results of his researches in this direction.

ON THE DECOMPOSITION OF CYANIDE OF MERCURY AND CYANIDE OF SILVER BY HEAT.

By E. MAUMENÉ.

It is well known that cyanide of mercury—in which the cyanogen appears to play the part of a simple body—is far from being decomposed by heat, like mercuric oxide, and giving $C_2NHg = C_2N + Hg$. There remains in the tube a brown residue, considered to be $(C_2N)^x$; but nobody has yet found the value of x. What is the origin of this body?

The "Théorie Générale de l'Action Chimique" gives—

$$\boxed{M} \quad n = \frac{100}{26} = 3{\cdot}85,$$

a number which may be corrected to 4·00.

$$4(C_2NHg) = (C_2N)_4Hg + 3Hg.$$

The 3Hg which remain free can only volatilise.

Experiments made on an oil-bath give results absolutely concordant. Up to 320° nothing takes place, but at this point vapours of mercury are given off, and condense in the tube without the slightest trace of cyanogen. The tube should be plunged in melted solder. Up to 400° nothing but Hg is vapourised: at a little over this temperature (as Troost and Hautefeuille observed in sulphur vapour) the $(C_2N)_4Hg$ is destroyed, and cyanogen is liberated abundantly: The para-cyanogen *in this case* has for formula $(C_2N)_4$.

We can easily foresee a similar decomposition for cyanide of silver, and confirm it by experiment.

$$\boxed{M} \quad n = \frac{108}{26} = 4{\cdot}15,$$

corrected to 4·00. $4(C_2N + Ag) = (C_2N)_4Ag + 3Ag$, 3Ag remaining free but unable to disengage itself. Mercury mixed with the cooled residue at the moment when the first bubble of cyanogen appears, dissolves 3Ag. We know that nitric acid also dissolves the Ag set free, and that, even after having exhausted the calcined matter, the residue contains 40 per cent of silver. This acid, mixed with four times its weight of water, is able to separate the $(C_2N)_4Ag$ from 50 per cent of silver, confirming the "Théorie Générale." The cyanides decomposable by heat give decidedly analogous results.

ON THE ACTION OF NITRIC ACID ON METALS.

By E. MAUMENÉ.

Tin left in very weak nitric acid produces nitrate of tin and ammonia; this is a well-known fact. But nobody has given an exact equation of this reaction. With the intention of proving this fact to my class I performed the following experiment:—

$NO_5,(HO)_5 = 99$ gr., whose volume $\frac{99}{1{\cdot}361} = 72{\cdot}74$
And $5HO = 45$ " " " $= 45$
Making dilute acid .. .. .. 117·74
The atomic volume of tin being $\frac{59}{7{\cdot}34} = 8{\cdot}04$

$$\boxed{C} \quad n = \frac{117{\cdot}74}{8{\cdot}04} = 14{\cdot}64,$$

taken as 14·00. The reaction ought to be—

$$14Sn + NO_5(HO)_{10} = 8SnO + 6Sn + NH_3 + 7HO.$$

In other terms, if we could realise two layers extremely thin, the action would only give protoxide of tin and ammonia.

In the gyratory apparatus, which I have described on page 510 in my "Théorie Générale," we get very near this condition; and, in fact, if we put it in very rapid rotation, and put in a little scrap tin, and slowly add the right quantity of acid, ammonia is formed in large quantities, and unites with the surrounding layer of acid without our being able to stop its complete neutralisation. But, on the other hand, an enormous quantity of protoxide of tin is formed and remains free, with all its properties quite evident. Thrown on a filter after separating the solution of ammonic nitrate, which is quite free from metallic tin, it produces with nitric acid a lively disengagement of NO_2, and its brown colour changes to pure white (SnO_2), &c. The solution of nitrate of ammonia, perfectly neutral, mixed with KO only gives a small quantity.

All the actions of metals with nitric and other acid, either diluted or not with water, can be calculated and verified by experiment in strict accord with the "Théorie Générale." The same holds good with all other chemical reactions, without exception. Exceptions do not exist in this theory.

Peptones and Alkaloids.—M. Ch. Tanret.—The author criticises the process lately given by MM. Brouardel and Boutmy, for distinguishing between the animal and the vegetable bases. The reduction of ferricyanide is certainly obtained, but it is not instantaneous, appearing only after the lapse of a few seconds. The reduction is produced almost in the same manner with crystalline ergotine, aconitine, and digitaline. It is instantaneous with eserine liquid, hyoscyamine, and amorphous aconitine, and ergotinine, as well as for morphine. Moreover, the list of vegetable alkaloids is far from being closed.—*Comptes Rendus.*

THE PRODUCTION OF PARAFFIN AND PARAFFIN OILS.*

By R. HENRY BRUNTON, M.Inst.C.E.

The discovery of paraffin wax, about 1830, was generally ascribed to Reichenbach, a German chemist; but, nearly at the same time, Dr. Christison, of Edinburgh, obtained a small portion of that substance from Rangoon mineral oil. The credit of producing this wax in merchantable quantities belonged, however, to Dr. James Young, of Kelly, in Renfrewshire. In 1848, Dr. Lyon Playfair directed Mr. Young's attention to an oozing of petroleum through a coal working at Alfreton, in Derbyshire. Mr. Young made arrangements to operate on this, and obtained a notable quantity of wax, as well as a light oil for burning and a heavy oil for lubricating purposes. After two years' successful working, the supply of petroleum at Alfreton ceased. Mr. Young then, as the result of numerous and protracted experiments, succeeded in obtaining, by the application of gentle heat to coal in close vessels, an oleaginous liquid similar in character to petroleum. Prior to this period (1848-9), the distillation of coal was conducted at high temperatures for the production of gas, Mr. Young being the first to attempt it with the ostensible object of obtaining liquid products. The process, the main feature of which was the gradual and gentle application of heat, was patented in 1850, and the patent was successfully maintained, nothwithstanding numerous attacks.

About the same time the Boghead or Torbanehill mineral was discovered, from which Mr. Young obtained 120 to 130 gallons of oil per ton. It was worked out in 1862, and paraffin oil had since been derived from the bituminous shales existent in the Coal Measures. From 80 to 90 per cent of that now worked was found in the counties of Linlithgow and Midlothian, and large fields were believed still to exist. The yield of oil from shale was only about one-fourth that from the Boghead mineral, yet the companies engaged in the trade were in a fair state of prosperity. There were eighteen establishments in Scotland for the manufacture of paraffin oil, using 1,036,000 tons of shale per annum, and producing 34 million gallons of oil. From this there were generally obtained, by the processes of rectification, 6 per cent of naphtha, 35 per cent of burning oils, 14 per cent of lubricating oils, and 9 per cent of solid paraffin, the remaining 36 per cent being lost. The lightest portion of the naphtha, known as "Gasoline," was employed for carburetting air for the illumination of country houses, &c.; other portions were used for burning in open-air lamps and for dissolving caoutchouc; while the heavy portion was applied for dissolving paraffin scale in the process of refining it. "Burning oils" were sometimes divided into lighthouse oil, which was of the greatest illuminating power and was the safest; No. 1 burning oil; crystal oil, which was No. 1 oil after treatment with acid and soda for removing its colouring matter and odour; No. 2 oil, and marine oil; but these varieties were generally mixed together and sold under various appellations.

By the Petroleum Act of 1871, the flashing-point, or temperature at which mineral oils should give off an inflammable vapour, was fixed as not under 100° F. This point was decided by the "open" test, but the results obtained by its means were variable and incorrect. By the Act of 1879 the test was made a "close" one, the apparatus designed by Professor Abel being employed; the "flashing-point" corresponding to 100° F., as made by the old test, being fixed at 73° by the "close" test.

The value of mineral oils as illuminants varied considerably. Lighthouse oil had been the subject of extended experiments; and whereas, when this was first used, a great advantage was apparent, both in consumption and illuminating effect, over vegetable oils, recent improvements in lamps made by Mr. James N. Douglass, M.Inst.C.E., and others seemed to have diminished, if not altogether to have destroyed, this superiority. But it was reasonable to suppose, owing to the larger proportion of carbon in mineral oil, that it should give better results if consumed to the greatest advantage: and, in consequence, the inference was that the lamps at present in use were not perfect in this respect.

The lubricating mineral oils had the defect of being deficient in body. The viscosity of an oil was tested by measuring the time a certain quantity took to pass through a tube, and by comparing this with rape oil as a standard. This being represented as 1000, mineral oils had a viscosity of from 250 to 400. They were therefore mixed with vegetable oils in certain proportions, and an addition of from 20 to 30 per cent was said to improve their lubricating properties.

Paraffin wax was of varied fusibility: that of a low melting-point was used in the manufacture of matches, and that having a higher melting-point chiefly for candles. Paraffin candles, which were made with a slight admixture of stearine, gave a clear smokeless flame, and a considerably superior light to sperm candles. It was claimed for paraffin that it was pure olefiant gas in a solid form, was converted into this gas when exposed to heat, and consumed without giving off any impurities.

The manufacturing processes for conducting the distillation of shale, introduced by Mr. Henderson, of the Broxburn Oil Works, Linlithgowshire, had led to the production of an oil of 1d. per gallon greater value, with an increased yield of ammonia, and at a saving of 1s. 6d. per ton, in fuel and maintenance of plant, on the shale dealt with. Mr. Henderson's retorts were placed in an oven above the combustion-chamber, and were not in direct contact with the fire. The carbon remaining in the spent shale was utilised, this being consumed as fuel for the retort, and by its slow combustion an equable temperature of about 800° F. was maintained. In the old form of retort the fuel used was coal, and the difficulty of maintaining a moderate temperature was so great that temperatures ranging from 1200° to 1500° were sometimes reached. The vapours from the retorts were led through a series of pipes, and partially condensed. The uncondensed portions were in some cases further subjected to condensation by pressure, or by a scrubbing process in a coke tower. The gas still remaining uncondensed was used as fuel. The ammoniacal liquor, which separated from the crude oil, was placed in boiler-stills, and the steam blown through sulphuric acid for the production of sulphate of ammonia. By arresting the process before the formation of crystals in the "cracker" box, and allowing some time for the precipitation of the arsenic and iron, and afterwards effecting the crystallisation by means of the evaporation of the liquid, an excellent commercial salt was produced from sulphuric acid made from pyrites. The first step in the treatment of the crude oil was its distillation to dryness, when pure vesicular coke was left in the bottom of the stills. The oil was then subjected to an acid and alkali treatment, and was fractionally distilled, being divided into naphtha burning oil, and a heavy oil containing 30 per cent of paraffin scale. The burning-oil portion received another acid and alkali treatment, and was again fractionally distilled, when more naphtha was separated, as well as a heavy oil containing 10 per cent of a more fusible paraffin. The burning-oil then received a final treatment, and on distillation was divided into the different qualities already mentioned.

Naphtha was rectified by distillation and treatment, it being also separated into the different gravities required by consumers. The heavy oil, from the first stage of purification, was run into bags, which were squeezed in hydraulic presses, and in this way a portion of the scale was separated. The oil so squeezed out, as also the heavy oil from the second stage of purification, was cooled by being put over a drum refrigerated by ether-machines, to 18° to 20° F., and was again squeezed, when more scale was obtained. Different methods were adopted, both for

* Read before the Institution of Civil Engineers, May 31, 1881.

the separation of the scale from the cooled oil and for lowering it to the necessary temperature.

The paraffin scale was refined by being dissolved on three occasions in naphtha, again crystallised by cooling, and squeezed under hydraulic pressure. Its deodorisation was effected by blowing steam through it, when in a melted state, for sixty hours: it was then agitated with animal charcoal, and was run through a paper filter into suitable moulds. The oil, pressed from the paraffin scale, received certain chemical treatments and was fractionally distilled, being separated into the required gravities, the light portion being returned as burning oil, and the remainder becoming lubricating oil, of 865, 875, 885, and 890 gravities. Any paraffin scale which these might contain was further separated by being refrigerated and pressed as already described.

The tar from the acid treatments was heated in large tanks to about 150° to 200° F., and the dilute acid and oil in it set free. It was then consumed as fuel, either in the furnaces of the boiler stills or with the object of evaporating dirty water. The soda contained in the tar from the alkali treatments was recovered by a process devised by Mr. Galletly, a chemist in the employment of Young's Company at Addiewell, 50 per cent of the soda used being so recovered at a cost of about 3s. per cwt.

Owing to the demand for paraffin oils being principally in winter, large storage accommodation was necessary for the summer production. This was afforded by malleable iron tanks of 50,000 to 100,000 gallons each, as the oil only slightly affected that metal, while it had a rapid action on lead or zinc.

The Paper only professed to describe the mechanical means employed in the manufacture, and no attempt was made to explain the chemical principles involved.

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,
Member of the American Society of Civil Engineers.

(Continued from p. 277.)

To many people it is a favourite belief that ventilation should be in some way effected by a natural process. Windows and doors and open fires are the limit of artifice to be endured, houses being *presumed* in lieu of caves. There may be a fireplace with its chimney in the category of *natural* apparatus, although this was as artificial and as abstrusely ingenious to our ancestors of five or six hundred years since as the best steam or hot water heating apparatus is to us to-day. Perhaps to quote from my former paper on moisture in air will be the best answer to such persons. "Clothing, houses, and fires are the means by which mankind is enabled to inhabit the earth. It is an artificial existence for an animal whose natural life would otherwise be limited to a small belt of the torrid zone, where the temperature never falls below 80 degrees, nor rises above 100 degrees." Fresh air will not be supplied naturally to a person in an audience hall, as one obtains it on a mountain top, at the sea-shore, or upon the deck of a vessel. Neither the currents nor the temperatures of the healthful breezes are admissible in the processes of *ventilation*, so that the natural supplies cannot even be simulated artificially. To meet the demand for health and comfort in the natural gregation of men, which is one of the conditions of advancement in civilisation, ventilation and warming must be effected with unnoticeable means and yet with positive results. Success in ventilation of halls can only follow the complete adaptation of mechanical appliances and apparatus, as well as of structural arrangements, to the ascertained wants and requirements of the individuals composing an audience. In all mechanical appliances that is simplest which most positively and directly effects the purpose in view; and in this matter of supplying air it may be claimed that the process of impelling it, when and where wanted, is at once the most certain and efficient, and that the fan (in its form of a rotating wheel with vanes for large uses) is the simplest and readiest machine for impelling air.

It will not be attempted at this time to discuss the theory of Rotary Fans. The fan itself will simply be accepted as one of the recognised appliances in the construction of ventilating apparatus, available with other mechanisms in established forms and defined types for American practice.

The fans most generally in use for the ventilation of large buildings in America have been derived, in all essential particulars of conformation, from those designed by the writer for the United States Capitol at Washington in 1855 and 1856. These particular fans were based upon a type given by M. Combes (in his "Aerage des Mines"), where the fan blades or vanes were placed upon the face of a disk, and the fan itself thus constructed was located in front of a circular opening in the wall of a building, the wall forming one side of the zone of blades, in opposition to the outer edge or face of the disc, which formed the other side. In this construction no case whatever is demanded for the fan, which receives its air through the central circular opening in the wall, and delivers its air at all points of the periphery into a large but close room, from which room the ducts for conveying air branch in any desired direction.

The heating and ventilating at the United States Capitol was under the charge of Major-General M. C. Meigs (then Lieut. U.S. Engineers), who selected this type of fan as presenting certain structural advantages for its employment. The study of the conditions of fan construction, which was devolved upon the writer, led to some modifications in the forms of blades, &c., as accepted by M. Combes, with which changes these fans were employed in the ventilation of the United States Capitol buildings. More recently the disc type has been departed from, but in other respects the proportions of the Capitol fans have been followed, and have now become established in general practice. It was a recognised necessity that a fan should be reduced to its least practicable dimensions, and the most cursory observation showed that the passage of air through the fan itself was an accelerating flow, whose least velocity should be ,that at which the entering air approached the inner edges of the blades, and its greatest velocity should be that at which the escaping air left the tips of the blades; the action of the blades being to give an accelerating velocity, to be mainly derived from the increase of velocity of the blade surface as it became further from the centre. It followed as a resulting consequence that the area of any cross section of the passage through the fan (any one of which will be formed between the disc and wall or case side, and between any two blades) should reduce in proportion as the air accelerates, and that the air should thus be kept in contact with, and be acted upon by, the blades as the source of impulse. These propositions gave, for instance, where the disc of the fan was taken to have a diameter equal to one, the diameter of the mouth or central opening becomes seventy-four hundredths; the width of the fan at the mouth becomes seventeen-and-a-half hundredths; while the width at the periphery becomes one-tenth. The number of blades was found (by experiments as to most efficiency with several different numbers) to be about sixteen, a number giving the section of the several passages formed by blades, disc, and wall, most nearly a square one, or most nearly that section of a duct or passage where the sides offer the least resistance to flow of a fluid.

The advantages in effectiveness or economy in power over other fans as before made, with small central opening and great width of vanes in direction of the axis, is not very considerable; 10 to 15 per cent of higher useful effect

* A Paper presented to the American Society of Civil Engineers, January 26, 1881.

is all that can be claimed when 55 to 60 per cent is usual; but the advantage of obtaining at least twice the capacity simply by enlarging the mouth and by increasing the number of blades to suit their reduction in length, is of high importance when room to place a fan in a building is frequently one of the troublesome questions to be met. Since 1856 probably 150 of these fans have been put into use in various hospitals and public buildings. The principal modification adopted has been the frequent use of blades on both sides, with the same disc construction, sometimes (for fans of four to eight feet diameter) with iron in lieu of brickwork cases. This last arrangement presents some difficulties in the entering air passages, but it reduces the diameter of a fan to do any given work to seven-tenths that of a single disc fan.*

In general these fans are driven by a directly connected engine of suitable size: sometimes a belt and pulley is used for transmission from an independent engine. This condition, that of independence from other uses, is desirable for hall ventilation, so that an economy of working may be practised to meet the condition of occupied and unoccupied halls; but for hospital ventilation it is about as well to drive the fans from the general source of motive power always indispensable in large hospital establishments.

Boilers and their appliances, engines, &c., are not distinctive or peculiar to ventilating or heating apparatus, and call for no mention in this paper as to methods of construction.

The steam heating apparatus in all its details, as used in America, is peculiarly American, especially the apparatus of small wrought-iron tubes, which had its origin at the hands of the late Joseph Nason, between 1840 and 1850, and has now become one of the established industries of the land, employing a whole class of workmen known as steam-fitters, and supporting large establishments devoted entirely to the manufacture of and trade in tubes and fittings.

The little step in mechanism which is the foundation of this art is found in the use of the tapering thread on the end of the pipes, wherewith a perfectly staunch joint is cheaply provided and made. It is curious that with over forty years' practice in steam-fitting, until no workman in iron regards this taper screw joint as other than the matter-of-course way of making a pipe-joint, with this established habit of workmanship, no description or notice of the tapering screw is published in any text-book, nor have its peculiar advantages been considered by any general writer on constructive mechanism. The great importance of this improvement in making the joints of steam pipes to this industry of steam heating can scarcely be over-estimated; but it was not only in this particular, but in many others of detail, that Mr. Nason's ability as an inventor and adaptor was shown in the apparatus: while super-eminent above this, he was at once the best informed of his day on the theory, and the most able in the practice, of steam-heating. Under his tuition the whole trade originated—ten or twelve years since it was possible to trace the descent or pedigree of any concern in the business to the original source—at this time; the growth of the business going to a third or fourth race of firms or workmen pre cludes the following out of the continuity, although it certainly exists. The business, however, has been, and is, dependent upon the development of mechanical ingenuity, mainly from Joseph Nason, who gave form to the globe-valve, originated and derived or adapted from the practice of hot-water heating apparatus in England—either the Perkins's high pressure or the greenhouse low pressure system—all the essential details which now form parts of usual everyday construction in the United States. Curiously, steam-heating as practised here, is not yet fully known or used in England or France, and but little more known in Germany.

The writer of this paper became connected with Mr. Nason in 1848, when he was employed to superintend the construction of tube works at Malden, near Boston, for Messrs. Walworth and Nason, and from that time until now he feels able to claim some standing in advancing the industry of steam-heating. It will have been noticed by most who have to do with construction that the form and shape of valves, elbows, tees, and of details generally employed or made at any time in the country are strikingly similar. In fact they are universally copies, following exactly the designs and proportions, as to sizes and thicknesses, which the writer established and published in the catalogues of the Pascal Iron Works, nearly twenty years since.

From this general acceptance of the types of steam-heating apparatus and component parts anyone is at liberty to specify a definite construction of coils and mains with a correspondence of detail. He can measure and plan to use any arrangement of standard articles, selected from any trade catalogue of a steam heating establishment or firm, and feel sure that the work will have been so arranged that it can be bid for in open competition, and that he is getting the best work, or details of work, to effect his purpose in his own way. More than this, it may be regarded as tolerably sure that any patented improvement of detail or method is inferior to what can be procured and supplied from regular traders.

(To be continued.)

* The only full published account of this fan is to be found in the *Proceeding of the Institution of Civil Engineers*, 1869-70, but the publication in the catalogue of apparatus of the Pascal Iron Works, Class IV., 1863, and subsequently, gives essential particulars, and has perhaps much aided in the introduction of the fan. The catalogue was compiled by the writer of this paper.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 16, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The following certificate was read for the first time.—F. Sear.

During the evening a ballot was held, and the following gentlemen were declared, by the Scrutators (Messrs. Groves and Warington) to be duly elected Fellows of the Society.—A. B. Avarne, G. H. Bostock, W. Bedford, B. Browning, J. M. Collett, A. W. Duncan, J. E. Doyle, A. E. Davies, H. Frankland, A. J. Hailes, C. W. Marsh, A. Philip, T. K. Rogers, J. Schwartz, O. Trigger, G. Tate, J. P. Wilkes.

The President read a letter which he had received from Lieut.-Col. Malcolm, Hon. Sec. of the Museum Sub-Committee of the British Association, 17, Blake Street, York. It is intended to illustrate, at the forthcoming meeting of the Association, as far as possible, the progress which has been made in the construction of instruments of scientific research during the past 50 years. With this view scientific men, societies, and manufacturers, are invited to exhibit instruments of the latest patterns, and tools used in their construction, together with the instruments used in 1831. The Exhibition will last only from August 31st to September 8th. The President, therefore, invited Fellows of the Society who could exhibit such apparatus to forward, as soon as possible, details of the apparatus and space required to the above address.

Mr. W. H. Perkin then communicated a paper "*On the Isomeric Acids obtained from Coumarin and the Ethers of Salicylic Aldehyd.*" Some years ago, the author showed (*Chem. Soc. Jour.*, 1877, i., 388), that by the action of acetic anhydride and sodium acetate on the hydride of methyl salicyl, an acid (methyl-orthoxy-phenyl-acrylic acid) was produced. By treating the hydride of

salicyl in the same way coumarin was formed. Tiemann has since shown that this is preceded by the formation of coumaric acid, which has a constitution analogous to the above acid, but has an atom of hydrogen in place of methyl. Now coumarin when treated with alkalies gives a coumarate, which, however, splits up into coumarin when treated with acids; but if treated with methylic iodide, it produces a methylated acid of the same composition and, apparently, the same constitution as that obtained by the action of acetic anhydride on the hydride of methyl salicyl; its fusing-point is, however, nearly 100° lower than the acid from the hydride of methyl salicyl. It can be converted into it by the action of heat. The cause of this isomerism being unintelligible, the author has undertaken the present investigation for the purpose of examining the acids, their derivatives, and any homologues which might be formed from the other coumarins. The acid obtained from coumarin is called by the author the α-, the other β-methyl-orthoxy-phenyl-acrylic acid. The α acid was obtained in magnificent highly refracting crystals; it is changed into the β acid by heat and by violet or ultra-violet light. The two methylic ethers and the α- and β-ethyl acids were prepared and examined. Nascent hydrogen converts both acids into the same acid, dihydro-methyl-orthoxy-phenyl-acrylic acid. The actions of nitric acid and bromine were also studied and various derivatives obtained. Isomeric dibromides were obtained, and experiments made with the methylic ethers of the acids; the β-ether yielded 70 per cent of a dibromide, melting at 68·7°, and 30 per cent of a dibromide, melting at 125°; the α-ether yielded as a principle product a dibromide, fusing at 125° with a small quantity of the body melting at 68°. The action of bromine on the α- and β-ethylic ethers was also studied. The actions of fuming hydriodic and hypochlorous acids were examined. The derivatives from propionic and those from butyric coumarin were next prepared. These coumarins yielded acids analogous to that from ordinary coumarin. From the author's researches, it appears that in general, the effect of chemical action on the α acids, is to convert them into the same compounds as are yielded by the β acids under similar circumstances. This is probably due to the heat evolved by the chemical action converting the α into a β derivative. The limited action of bromine is an exception, but in this reaction but little heat is evolved. The hypothesis that the isomerism resulting from the difference of structure of this group is considered, but is not thought by the author to be established. The physical differences of the α- and β-ethers, described in the paper, are considered, and the author concludes that as the boiling-points, densities, refractive indices, &c., of the α compounds are all lower than those of the β body, and the α compounds are the less stable, it is probable that the molecules of the α body are further apart than those of the β body. Reference is made to the fact that the formation of these α bodies is always connected with dehydration and rehydration, and a suggestion is made that if a difference of proximity of the groups is the cause of the isomerism, it is probably due only to a difference of distance between the radical and the hydroxyl. It is also pointed out, that in most cases, where bodies are, what is called, physical isomerides, they are hydroxylised products.

Mr. FLETCHER then gave a short statement of the results which he had obtained from the measurement of the various crystallised bodies prepared by Mr. Perkin.

Dr. WRIGHT suggested that it would be interesting to determine the heat of combustion of one or more pairs of these α and β bodies.

Prof. HARTLEY thought that probably some difference might be found in the optical transparency of these isomeric bodies.

Dr. ARMSTRONG then communicated a paper by Mr. G. LOWE and himself, entitled "*Notes on Naphthalene Derivatives.*" The authors have continued their investigations as to the action of sulphuric acid on naphthalene, and confirm their previous statement that three and not two disulphonic acids may be obtained. By operating at 180°, a mixture in about equal proportions of the α and β disulphonic acids of Ebert and Merz is obtained; but at 100° a third acid is also formed, corresponding to the dihydroxy-naphthalene melting at 156°, which they have described. This third acid is obtained in relatively small quantity, and the authors have not yet established the conditions which are most favourable to its production, nor have they devised a satisfactory method of separating it from the isomerides. They have confirmed their observations on the action of fused potassium hydroxide on potassium β-naphthol-sulphonate, but doubt whether more than a single body is produced in the reaction. It crystallises from hot water (in which it is much less soluble than the dihydroxy-naphthalene previously described) in small plates melting at 218° to 220°: it separates from acetic acid in large ammonium chloride-like forms. The alkaline solution exhibits a blue fluorescence, and rapidly darkens on exposure to air. Dr. Armstrong then described an isomeric β-naphthol-sulphonic acid obtained by Mr. Stallard and himself by dissolving β-naphthol in cold concentrated sulphuric acid. The authors were led to the discovery of this substance by noticing that when less sulphuric acid than Schaefer prescribes for the preparation of β-naphthol-sulphonic acid is used, it is difficult to obtain the salts in the clear transparent crystals so characteristic of the β-naphthol-sulphonates. The salts of the new acid are much more soluble, and when submitted to the action of bromine or nitric acid readily exchange the sulpho group for bromine or NO_2, forming bromo- and nitro-derivatives of naphthol. The acid previously known retains its sulpho-group under similar treatment. Dr. Armstrong demonstrated this reaction to the Society, and pointed out that it was a good lecture illustration of the extraordinary difference of the SO_3H group, according as it occupied the so-called α or β position in naphthalene.

Mr. G. S. JOHNSON then read a paper "*On the Synthesis of Ammonia (Third Notice).*" This paper is practically an answer to the criticism of Mr. L. Wright on the previous communication of the author. Mr. Wright stated that the nitrogen used by the author was not pure, and that it contained nitric oxide, and that the ammonia formed was due to the presence of this impurity. The author of the present paper points out that he relied for the purification of his nitrogen from nitric oxide not on an acid solution of ferrous sulphate, but on pumice impregnated with hydrated ferrous oxide precipitated by the ammonia evolved on boiling the ammonium nitrite. He has repeated his previous experiments, and tested the N carefully for NO by mixing with air and bubbling through starch and potassium iodide solution. Although no blue colour was seen in half an hour, yet this pure N when mixed with H still formed ammonia. Other experiments were made in which the nitrogen was purified by mixing with air and allowing the mixed gases to stand for some hours over water rendered alkaline with potash. This also produced ammonia when mixed with hydrogen and passed over spongy platinum. The author finds that when the pure nitrogen is passed through heated asbestos before mixing with hydrogen it is no longer capable of combining with hydrogen in the presence of spongy platinum. This experiment was exhibited to the Society. As long as the asbestos was hot no ammonia was produced, but on allowing it to cool, after about twenty minutes a Nessler solution became distinctly yellow. The author thinks that this experiment indicates the existence of an active allotropic nitrogen analogous to ozone, and hopes to produce further evidence on this subject. He concludes that he has proved that the synthesis of ammonia from hydrogen and nitrogen, obtained by the action of heat upon a solution of ammonium nitrite, is possible in the presence of spongy platinum.

Mr. J. MOND said that after two years' work at every conceivable means of causing the direct union of nitrogen and hydrogen with spongy platinum, platinised asbestos, &c., he had only met with negative results, and had come

to the conclusion that the silent discharge was the only means of effecting the direct union of these two elements.

Mr. W. A. Shenstone then read a paper "*On the Alkaloids of Nux Vomica.*" The author has, with the aid of Messrs. Hopkin and Williams, extracted the alkaloids from 56 lbs. of the seeds of *Strychnos Nux vomica*. His object was to prepare and examine the alkaloids prepared by using as little heat as possible, and avoiding heat in the presence of acids or alkalies altogether. The process used is similar to that employed by Dr. C. R. A. Wright. A solution of sulphate of brucine was finally obtained, from which the alkaloid separated on exposure to ammonia vapour. The brucine was finally purified by conversion into hydriodide, regeneration with sodium carbonate, &c. The brucine obtained did not yield any evidence of the presence of strychnia, and gave a crystalline acetate. Many analyses of the product are given, which agree with the formula $C_{23}H_{26}N_2O_4$. About 20 ozs. of mixed crystalline alkaloids were obtained. The author searched the mother-liquors very carefully for the so-called isagurin, but all such bodies were proved to be brucine with a trace of some persistent impurity. By the action of alcoholic soda on brucine a hydro-brucine, $C_{23}H_{28}N_2O_5$, was obtained. Its colour reactions are distinct from those of brucine.

Prof. Hartley then read a short paper entitled "*Notes on Photographs of the Ultra-violet Emission Spectra of certain Elements.*" The author draws the following conclusions:—The ultra-violet spectra are comparatively free from air-lines. All the most important groupings of metallic lines appear in the ultra-violet region. The sharp clear cut appearance and the nebulous character of certain lines are even more strongly marked than in the visible spectrum. Not only are long and short lines noticeable, but many rays which consist of mere dots are characteristic of certain spectra, while certain strong lines appear to stretch not only across the spectrum, but above and below its boundary edge. When the photographs of the elements are arranged in Mendeleeff's series certain well-defined groups exhibit similarities in their spectra, *e.g.*, Mg, Zn, and Cd; Fe, Co, Ni: Al, In, Tl; Cu, Ag, Hg. Palladium also has a spectrum somewhat similar to the spectra of the iron group. Prof. Hartley exhibited some of the beautiful photographs on which the above statements are based.

Mr. S. U. Pickering gave a brief statement of the results arrived at in his paper "*On the Sulphates of Aluminium.*" He has examined the seven or eight sulphates of aluminium which are said to exist, but has in most cases not been able to find any evidence of their existence.

"*On Two New Oxides of Bismuth,*" by M. M. P. Muir. The author has repeated Boedeker's experiments on the action of aqueous potassium cyanide on a hot nitric acid solution of bismuth nitrate, but finds that the puce-coloured salt which is produced has the formula Bi_2O_7, and not $Bi_2O_5,2H_2O$, as assigned to it by Boedeker. The new bismuth heptoxide is a fairly stable compound towards heat: it begins to part with oxygen at about 200°; soluble in acids, giving deep red liquids, which are only very slowly decomposed and decolourised by boiling. A hot concentrated solution of caustic potash dissolves 25 per cent of the new oxide, forming a very deep red liquid, from which acids throw down a red-brown substance containing bismuth, oxygen, and much water, but, after washing with hot water, free from potassium. The portion insoluble in hot potash consists of another new oxide of bismuth. Bismutho-hypobismuthic oxide, Bi_4O_7, sp. gr. 8·5, reacted on by potash, dissolves in acids to purple-red liquids, only very slowly decomposed by boiling; does not lose oxygen till heated over a Bunsen lamp. Neither oxide takes up water from moist air.

The Society then adjourned over the summer recess.

NOTICES OF BOOKS.

The Law of Therapeutics, or the Science and Art of Medicine. By Joseph Kidd, M.D. Second edition. London: C. Kegan Paul.

"He is a truly scientific physician," says the author, is now often a by-word for contempt. There are, it must be admitted, medical practitioners without end who, contrary to the vulgar notion, are not in any sense "men of science." They reject all modern instruments and modes of research; they laugh at the use of the microscope and of chemical reagents in ascertaining the nature or the cause of disease. They have no good word to say for physiological investigation, and sometimes, in consequence, throw themselves into the arms of the anti-vivisectionists, who are not slow to parade them as "scientific" converts to the agitation. Such men, though making no advances in medical theory, are not unfrequently successful routine practitioners, guided by tact rather than by definite principles. Dr. Kidd aims at something the very opposite. He holds that "of all studies, that of Therapeutics, or the treatment of disease, ought to be the most accurate." Where human life is at stake it saddens him to think how much still depends upon chance. What man accustomed to exact scientific work does not share this feeling? In his historical survey of therapeutic laws, or rather the gropings after such, many interesting facts are brought into view. It is shown that hospitals were not, as Dr. Farrar assumes, unknown to the civilisation of antiquity. The dispensary of the ancient Egyptians and the "Asclepias" of the Greeks contained the germ of the modern hospital. Perhaps the canonisation of personal dirtiness and the abolition of the Roman baths, effected in obedience to the dictates of Oriental asceticism, made the need and the scope for hospitals all the greater.

Of Haller, the author speaks, in our opinion, much too highly. There must have been something sadly wrong in the mind of the man who could "damn himself to everlasting fame" by such an utterance as his "*nulla est epigenesis!*"

Of Hahnemann and his system, the author takes a discriminating view. He admits the so-called fundamental homœopathic principle, "*similia similibus curantur*," as an important therapeutic law, though not indeed to the exclusion of the antipathic law of Galen, *contraria contrariis curantur*. But the developments of homœopathy, the infinitesimal doses, and the idea of "potentiation" or dynamisation, Dr. Kidd treats with the contempt which they experience and deserve from men of scientific habits of thought. He appeals from Hahnemann drunk with mysticism to Hahnemann sober, and he considers that medical practice generally has been modified for the better by the promulgation of homœopathy.

A passage concerning the researches of Dr. Brown-Séquard should not be overlooked in the present fanatical temper of a large part of the British public:—"When Brown-Séquard, the distinguished man of science, settled down to practise medicine in Cavendish Square and at the National Hospital for the Paralysed and Epileptic, he quickly showed that the most minute and delicate experiments upon animals were to throw a flood of light upon the medicinal treatment of the diseases of man. Many epileptic and paralysed patients have had cause to bless the labours of the man who for so many years patiently experimented upon guinea-pigs and rabbits in the causation of epilepsy and paralysis."

"It is fashionable," says the author, "now-a-days for every clever writer to explain that disease is not an entity or a substance." Yet, as he adds, the poisons of cholera, typhoid, and doubtless other diseases are very positive entities from without. Of "expectant treatment," he writes that "Hospital physicians, accustomed chiefly to recent cases of disease, mostly of sub-acute nature, find good feeding, nursing, plenty of fresh air, and perfect rest,

do so much for their patients—often moved from homes devoid of any hygienic attribute to the large airy wards of the hospital—that they are apt to lose faith in medicine. To them it is much to abstain from the routine of evil drugging. The contrast of their results is so decidedly favourable in comparison with the bleeding, leeching, and blistering of an age not quite gone by; but away from the hospital, among varied and perplexing chronic diseases the fashion of scepticism with regard to drugs avails but little."

Dr. Kidd recognises the "*vis medicatrix naturæ*," but it seems that he overlooks that counter-agency which the late G. H. Lewes well named the *vis deletrix*.

The author's remarks on food are highly judicious. He is not an adherent of any of the modern fanaticisms, such as teetotalism, or that pseudo-vegetarianism which rejects beef and mutton, whilst tolerating milk, cheese, and eggs. Yet he is no friend of the indiscriminate use of alcoholic stimulants, and he believes in milk to an extent scarcely justifiable in times when so many cows are known to be affected with tubercular disease. He complains that the "doctor is beset by a multitude of infant's foods. These evils—for evils they are—and quack medicines as well, would soon disappear if the law of libel were cut down to reasonable limits, so that they might be safely criticised.

We regret our inability to devote more scope to Dr. Kidd's volume, and we trust that its teachings will be fully appreciated by the profession.

Tin, a Geological-Mining-Historical Monograph. (Zinn, eine Geologisch-Montanistische-Historische Monografie.) By E. Reyer. Berlin: G. Reimer.

The author of this useful compilation divides his subject geographically. He treats, first, of the geology of the Saxon and Bohemian tin regions, and gives a history of tin mining at Graupen, Altenberg, Zinnwald, Platten, Erenfriedersdorf, Geier, and Schlackenwald. It appears that the tin-deposits were discovered and utilised as early as the 12th century. In the 15th century the produce of the Saxon and Bohemian tin mines was greater than that of Cornwall, but it has since fallen into comparative insignificance. Most of the mines have been abandoned in the present century, and in 1850 the entire yield of the Erzgebirge was only 2500 cwts. Since that time it has not increased.

Passing over to England, the author describes the geology and the mining industry of Cornwall and Devon. There is appended a glossary of the peculiar Cornish technical terms for rocks and minerals—a language not much more intelligible to the ordinary Englishman than to the foreigner, and which on the "*omne ignotum pro magnifico*" principle, greatly aids promoters of mining companies in mystifying the public, since it is brought into use in every part of the world where Cornish mining engineers are sent.

The tin deposits of Spain, Portugal, France (Bretagne), Italy, Finland, Sweden, Greenland, and Siberia are also noticed.

Of more importance are the tin mines of south-eastern Asia. Not merely the Malay peninsula and the islands of Banka and Bilitong, but the entire eastern coast of the Bay of Bengal, Java, Sumatra, the western coast of Borneo contain deposits of this metal. The Banka tin works are no longer so productive as in the years 1855-59, but the average yield is still about 4400 tons.

The total Australian production for the year 1877 is given as 13,000 tons. As regards the future of Australian tin mining the author takes a judicious view intermediate between the pessimist accounts of Cornish mine owners, anxious for high prices, and the exaggerated views of the Australians.

The North American production of tin is insignificant. Peru, Bolivia, and Chili yield small quantities, but the Peruvian tin is contaminated with tungsten, arsenic, and antimony, and is consequently not in request.

The remainder of the book is devoted to an account of the probable origin of tin ores, and of the smelting processes adopted in the different districts. The applications of tin are briefly noticed, its uses in the art of dyeing being dismissed in a few lines. Various processes for the recovery of tin from tinners' waste, clippings, &c., are noticed. The work is enriched with a very complete bibliography of the subject.

The following consideration with which the author concludes may throw a light on the general average of profit which may possibly be expected from mining. During the last 500 years in the mere process of separating the tin ore from sand, &c., 1,462,000 masses of earth and stone, ten metres high by the same measurement in length and width have been worked through, sifted, and washed! If we consider that it takes a man, on an average, a day to work through a ton of detritus, we have three milliard days' works spent in this one department of tin winning!

Education, Scientific and Technical; or How the Inductive Sciences are Taught and How they Ought to be Taught. By Robert Galloway, M.R.I.A., F.C.S. London: Trübner and Co.

The subject of this book is, as the author admits, inadequately expressed by the title. Its object, whether successful or not, is one with which we most ardently sympathise: Prof. Galloway trusts "his work will assist in arresting the competitive examination system, at least in the Science Schools carried on by the Department of Science and Art, and by the City Guilds; a system which, with the exception of England, only retrograde nations, like China, adopt; and that it will aid in causing us to follow in our educational systems the examples set by enlightened nations like Germany."

This declaration gives the key-note of the entire work. The author sets out with the admission, now no longer suppressed, that we are far behind most of the Continental nations in scientific and technical education. The two commonly alleged reasons for this inferiority, viz., our later entrance into the field, and the lack of the necessary funds, he shows to be insufficient. As far back as 1787, the Society of Arts was alive to the importance of the question. Nor are the resources deficient. If we sum up the revenues of the universities and the endowed secondary schools, the sums voted by Parliament, or contributed by private munificence, for the promotion of higher education, the amount would be startling, and would, *if rightly applied*, secure for us, as the author says, "the best general, scientific, professional, and technical education of any country."

The question may next be raised whether we lag behind from any natural deficiency of the British and Irish mind? The author, in addition to other evidence which might have been found, brings forward German testimony to the contrary. Prof. Max Müller, who has had ample opportunities of observing, declares: "The intellectual fibre, I know, is not different in the youth of England and the youth of Germany."

The first cause of our short-comings may be found in that inbred dislike of organisation, which is perhaps our greatest national weakness. As Dr. Wiese declares, "an extraordinary amount of power, time, and money is still wasted from a want of plan and unity."

A second cause of our deficiency is our system of teaching, which is made to turn almost entirely upon honours and examinations. Some years ago we had a great outcry about "university reform." It was contended that the exclusive attention paid at Oxford and Cambridge to classics and mathematics was a mistake. The reformers were partly in the right. "Of observation, experiment, induction, analogy, the mathematician knows nothing." In a very similar manner the attention of the classicist finds his attention withdrawn from things and fixed upon words only. He never learns, or rather, he unlearns, to

observe forms, textures, colours, odours, grades of pressure, &c., or to note their differences and their likenesses. Instead of what *is* he cares merely what somebody has said about it. It is very significant, as the author quotes from Prof. Cooke, of Harvard University, that when the claims of scientific culture were first urged upon Oxford and Cambridge, they were opposed on the ground *that the experimental sciences could not be made subjects of competitive examination.* It is by no means clear to us that even Prof. Cooke feels the full absurdity of this argument. For what does it imply? Nothing less than a complete inversion of means and end. For even "eminent English scholars"—as distinguished from men of science—must admit that if the object of education is simply to pass an examination better than someone else, it is a mere waste of time. Unfortunately our sages have got over this difficulty. It was once remarked that if the ancient scholastics could have got hold of Newton's *Principia*, they would simply have erected a mountain of verbal disputations upon it. In a very similar manner our masters, tutors, and the like, having admitted the natural sciences in some sort into their colleges and schools, have simply made them also into a subject for examination papers. A reformation in the subjects taught is of very little moment without we amend the way of teaching.

In Germany "the principle of competition is almost entirely excluded as tending to foster a servile view of education, and to lead to spasmodic and exhausting efforts and feverish excitement rather than the healthy and harmonious development of the mental powers. The students' powers are carefully husbanded for employment in the serious toils of mature intellectual life: in England they are wasted in a ruinous and unmeaning rivalry of striplings." Instead of teaching a man how to *do* a thing we cram him to pass an examination in it.

Now there is scarcely a man whose opinion is worth the smallest scrap of paper upon which it could be written but condemns, more or less openly, our examinational system. Still it survives, and there is no immediate sign of its breaking up. The school master who should rise to a higher idea of education would simply lose his pupils. Where to make a beginning is the difficulty. If we had sufficient influence we should exhort all who have the disposal of appointments in their hands to announce "no examinees need apply."

The author's remarks on teaching chemistry are exceedingly valuable. He complains that our elementary chemical treatises, numerous as they are, are not simplified, but merely diluted. He considers that chemistry, as long as taught by the present methods, will never prove of any value to those who study it as a branch of general education (*i.e.*, to nine students out of every ten), but only to those who study it as a profession, and even the latter might become sooner and better acquainted with it than at present. The author's own system appears to have proved successful both at schools of a lower grade and at the Museum of Irish Industry.

In concluding this brief notice we will merely wish this book an extended circulation, and its ideas a still wider appreciation. It is a manly and an enlightened attempt to declare, as does Prof. Galloway, war against an increasing evil, the real nature and magnitude of which few have realised.

Illusions, a Psychological Study. By James Sully. London: C. Kegan Paul and Co.

The object of the author in the present volume is to "take a wide survey of the field of error," including not merely the ordinary illusions of the senses, but other errors, similar in their mode of origin. Although the work is avowedly addressed in chief to psychologists it is not without profound interest for the student of physical science, who has carefully to avoid finding his own hypotheses and expectations in the phenomena which he is observing. Mr. Sully makes the happy remark that:—"Our luminous circle of rational perception is surrounded by a misty penumbra of illusion." He distinguishes illusion from hallucination thus: The former is a mere partial and the latter a total displacement of external fact by a fiction of the imagination, but he admits that the line is narrow. He distinguishes illusions according to the kinds of knowledge which they simulate, *i.e.*, those of perception, of introspection, of insight, of memory, and of belief.

In the section on the illusions of perception, which will have for the majority of our readers the greatest importance, we particularly notice the author's discussion of the effects of expectation. He distinguishes here *sub-expectation* and *vivid expectation.* In the former state, though not distinctly anticipating any one kind of object, we think that something will happen or be seen. Any emotion throws the mind more or less into this state. A feeling of awe makes us ready to perceive whatsoever is strange, mysterious, or apparently supernatural. In vivid expectation some one thing is looked for, and, in consequence, it is supposed to be seen, heard, or felt. A characteristic instance is here quoted which may be true:—"An officer, who superintended the exhuming of a coffin, rendered necessary through a suspicion of a crime, declared that he already experienced the odour of decomposition, though it was afterwards found that the coffin was empty." Of a like origin is the evil odour which so many persons at once experience if they learn that a chemical manufactory, or especially sewage-works, exist anywhere in the neighbourhood. We have heard of an establishment of the latter kind having been complained of as an actual—not prospective—nuisance, when it merely existed as a plan in the engineer's office! How widely perception of another nature may be vitiated by expectation is shown in an incident which happened when Davy first exhibited the properties of potassium to his contemporaries. A gentleman of some scientific merit, lifting up a portion of the new substance, exclaimed, "Yes, it is certainly metallic, and very ponderous"! Such facts may well impress upon young chemists and physicists the necessity of great caution when investigating a new subject. It is a wise precaution in all cases where expectation may be the father to perception to submit the phenomenon to the view of some acquaintance who is expecting nothing. But we have eminent, or at least noisy men, who, lest they should see or hear what is non-existent, fall into the counter-illusion, and do not see phenomena really in their presence.

We regret that want of space does not allow us to extend any further our survey of this important work, which we can recommend as a masterly exposition of its subject.

Annual Report of the Director of the Mint to the Secretary of the Treasury for the Fiscal Year ended June 3, 1880. Washington: Government Printing Office.

This report is in its nature fiscal and statistical, and does not furnish any novel information on refining and assaying.

An Elementary Course of Practical Physics. By A. M. Worthington, M.A. London: Rivingtons.

The author's object in this work is to propose a course of physical instruction, calculated to afford a good training in skilful manipulation, exact observation, intelligent and orderly recording of phenomena observed, the intelligent application of arithmetic, geometry, algebra, and the varying of experimental conditions. He enumerates the articles required for his course, and shows that to fit a school laboratory for really useful work does not involve any really formidable outlay. He deprecates "cram," as does every man whose opinion is worth the scrap of paper upon which it can be written. But cram still goes on increasing, and will increase till the educational world has its Cromwell with the will and the power to do away with

competitive examination in its every form. We are not disposed to differ from Mr. Worthington in his high estimate of the value of physics as an agent for the cultivation of the intellect. The author's rules to be observed by boys working in the laboratory are very judicious.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 20, May 16, 1881.

Transformation of Morphine into Codeine and Homologous Bases.—M. E. Grimaux.—Codeine is a methylic ether of morphine, and from the latter may be obtained a series of new bases, of which codeine is the type and morphine the substratum. The author gives these compounds the generic name of codeines. Codeine is codo-methyline, and a base, which the author has discovered, $C_{19}H_{23}NO_3$, is codethyline.

Principle of the Conservation of Electricity.—M. G. Lippmann.—The principle of the conservation of electricity is expressed by the condition of integrability (α). It is susceptible of new applications, and permits us, not merely to analyse certain phenomena, but to deduce from the them existence and the law of new phenomena, which experiment has not yet detected. As the first example, he shows that what may be called the coefficient of electric contraction of a gas is equal to its refractive power for light. The author applies the same analysis to various electric phenomena, such as the expansion of the glass of a Leyden jar during charging; electrisation by the compression of hemihedral crystals; the pyro-electricity of crystals. Among other results are the existence of the following phenomena not yet verified by experiment:—(1) The dielectric power of glass augments under the action of mechanical traction; (2) non-superposable hemihedric crystals change their form when submitted to electric influence, and this deformation is sometimes opposite in direction to that which electric attractions tend to produce; (3) a pyro-electric crystal becomes heated or cooled on the approach of an electrised body, according as such body is in a positive or negative state. The phenomena thus foreseen are the inverse of the phenomena from which they are deduced. To establish their existence, the equation (α) is each time necessary; the principle of the conservation of energy taken alone does not suffice.

Theory of Rotatory Polarisation.—M. En. Mallard.—A mathematical paper, not adapted for abstraction.

Graphic Method of Representing the Phenomena brought into Play in Dynamo-electric Machines.—M. Deprez.—The author has found a graphic procedure of great simplicity, which enables him to calculate directly the value of the current produced by a dynamo-electric machine in all possible conditions of the speed of the ring and the resistance of the outer circuit. This process is based on the construction of an experimental curve which varies in each machine, and which the author calls the "characteristic" of the machine. To construct it, every communication between the ring and the electro-magnets' excitors is suppressed, and the current of known strength is turned into the latter; an arbitrary speed of rotation is then given to the ring, which is the same in all the experiments. We measure then by any known method, the difference of potential which exists between the two extremities of the induced circuit, which is broken. If we vary the intensity of the auxiliary current thrown round the electro-magnets, the difference of potential of the extremities of the induced circuit will undergo corresponding variations, and on taking the intensities of the auxiliary current as the abscissæ of a curve, and the differences of potential of the extremities of the induced circuit as ordinates, the characteristic curve is obtained.

Hydrates Formed by Chloride of Calcium.—M. H. Lescœur.—The author considers that the existence of hydrates, containing respectively 1, 2, 4, and 6 mols. of water may be admitted.

Solubility of Mercurous Chloride in Hydrochloric Acid.—MM. F. Ruyssen and E. Varenne.—The solubility of mercurous chloride, unlike that of silver chloride, is greatly dependent upon time of contact.

Non-Existence of Microzyma Cretæ.—MM. Chamberland and Roux.—The authors controvert, experimentally, the presence of a supposed ferment in chalk as assumed by M. Béchamp, in 1866.

Crystallisation of Alums.—M. A. Loir.—The various faces of a crystal have not all the same power of attraction for a body contained in the solution employed to feed the crystal.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 11.

Simple Method of Determining the Temporary Hardness of Water.—V. Wartha.—In order to ascertain the alkalinity of springs on the spot, with samples not exceeding 10 c.c., and with a single reagent, the author makes use of a tube of 30 to 40 c.m. long, closed at the bottom, and with a mark showing the capacity of 10 c.c. From this mark upwards the tube is graduated into 0·1 c.c. To determine the temporary hardness the tube is filled to the lowest mark with the water in question, and a little piece of filter-paper, which has been previously steeped in extract of logwood and dried, is thrown in, thus giving the water a violet colour. Centinormal hydrochloric acid is then added from a dropping bottle, till the colour of the liquid inclines to an orange. The tube is then closed with the thumb and well shaken. The greater part of the carbonic acid escapes, and the liquid becomes red again. Acid is again added, and the shaking repeated until the next drop of the acid turns the liquid to a pure lemon-yellow, a point which a little practice is easily reached. The amount of acid used is read off on the tube itself. The author proposes to express the alkalinity of a water by the number of c.c. of centinormal acid needed to neutralise 10 c.c. He thinks that this method will be found useful both for sanitary and geological purposes.

Chemistry of the Platinum Metals.—Theodor Wilm.—Contrary to the prevalent view, all the platinum metals, if precipitated by zinc in a state of very fine division, are soluble to a considerable extent in nitric acid, whether weak or strong, so that palladium cannot be separated from such a mixture by means of nitric acid. The solubility appears to depend on the relative proportion of one or other of the metals in the mixture (mass action). Pure palladium, even in thin leaves, is not easily soluble in nitric acid, whilst all the other platinum metals are perfectly insoluble if in a moderately compact condition. Palladium cannot be isolated by agitation with mercury from a solution which along with the platinum metals contains base metals, such as copper, lead, &c., since the mercury precipitates, not merely the palladium, but all the other platinum metals, forming probably amalgams. From the platinum metals thus precipitated by mercury, metal free from mercury cannot be obtained by distillation and subsequent ignition, since a part of the mercury forms a stable compound with the platinoids.

Action of Bromine upon Toluol and Certain of its Derivatives.—C. Loring Jackson and A. W. Field.—This paper was read before the American Academy of Science on June 12, 1878.

An Explosion Furnace.—L. von Babo.—This memoir cannot be reproduced without the two accompanying illustrations.

MISCELLANEOUS.

An Industrial and Technological Museum.—An Industrial and Technological Museum of a very comprehensive character is in course of organisation at Sydney. It is to include animal, vegetable, and mineral produce in the crude and in the manufactured states; waste products, of whatsoever origin; foods with their constituents, and that necessary shadow side of the picture, their adulterations; educational appliances; sanitary apparatus and systems, models, plans, machinery, &c., for mining; agricultural machinery and manures; models, drawings, and descriptions of patents; a department of economic entomology; ethnological specimens, &c. One remark in the prospectus may call up a smile. The museum is intended to occupy a similar position to the South Kensington Museum. This might be construed to mean that it is to occupy a site as far out of the way of merchants, manufacturers, patentees, &c., as possible. We need scarcely say that the project has our best wishes.

Glycerin.—Notwithstanding the low price which now prevails for almost every description of raw produce and manufactured goods, there are a few articles which form notable exceptions. Perhaps one of the most remarkable of these is refined glycerin, which, within the last two years, has advanced from about £30 to £130 per ton avoirdupois for 30° B. This enormous advance is due partly to increased consumption, diminished production, and the influence of speculation working on a market devoid of stocks. In view of the present position of the article and the prospect of a continuance of high prices for a considerable time to come, the attention of soapmakers is now being turned to the utilisation of their waste "leys," and various new processes for recovering the glycerin contained in these liquors have lately been tried with more or less successful results. Apart from minor impurities, waste soap "leys" are generally found to contain glycerin, carbonate of soda or caustic soda, chloride of sodium, gelatin, and albumen. One of the processes for recovering the glycerin which promises to be the most economical and the most successful begins with concentrating the liquor until the salts contained therein begin to crystallise. The liquid is then cooled and filtered to rid it of gelatin and albumen. It is afterwards made to absorb carbonic acid, which precipitates bicarbonate of soda, and which is separated from the liquor in the usual way. After undergoing this process the liquor is then made to absorb gaseous hydrochloric acid until what remains of carbonate of soda has been converted into chloride, and further, until all, or almost all, the chloride of sodium has been precipitated and separated from the liquor in the usual manner. Arrived at this stage, the liquor contains water, glycerin, and hydrochloric acid. The acid is then evaporated entirely and absorbed in water for using afresh. The dilute glycerin remaining can be purified by filtering it through animal charcoal or by concentrating and distilling it in the usual way.—*Glasgow Herald.*

MEETINGS FOR THE WEEK.

MONDAY, 27th.—Royal Geographical, 8.30.

Society of Public Analysts, 8. "On the Estimation of Quinine in Wines, Tinctures, &c.," and "On the Figures or Patterns which Drops of Various Fats Assume under Certain Conditions," A. Wynter Blyth, M.R.C.S. "On a Modification of Wynter Blyth's Apparatus for Digestions in Ethers as Applied to Milk Analysis;" and "On a New Burner for Griffin's Gas Muffle Furnace," W. F. K. Stock, F.C.S., F.I.C. "Some Remarks on the Swedish Laws and the Quantity of Arsenic really Prohibited," C. Heisch, F.C.S., F.I.C. In reference to the Swedish laws for the sale of Poisons, Dr. Wallace will exhibit a certificate of a test for arsenic in a carpet, by the Government Chemist at Stockholm, with tube containing the result of the test and a piece of the carpet.

WEDNESDAY, 29th.—Society of Arts (Anniversary), 4.

TO CORRESPONDENTS.

A Correspondent.—We learn that the margarimeter can be obtained at 16, Rue Sauval, Paris.

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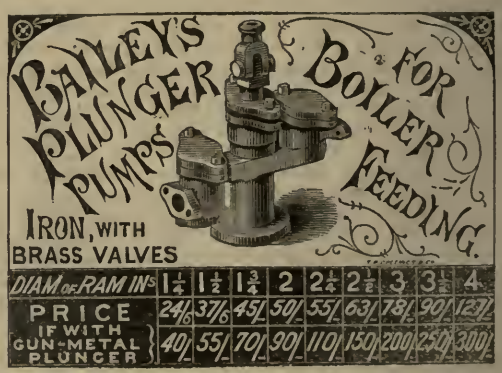

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SELENIUM AND ITS APPLICATIONS TO THE PHOTOPHONE AND TELEPHOTOGRAPHY.*

By SHELFORD BIDWELL, M.A., LL.B., M.R.I.

Before entering upon my subject, I must claim your indulgence upon two grounds. A week ago I had not the remotest idea that I was to have the honour of addressing you here this evening; the time which I have had for preparation has, therefore, been exceedingly limited. In the second place, it is my desire (in accordance with the traditions of this Institution) not merely to give a description of the experiments in which I have for the last few months been engaged, but, as far as possible, to reproduce them before you. Now, these experiments are mostly of a very delicate nature. In the quiet of a laboratory—where time is practically unlimited, and where an operation, if it should fail at first, may be repeated an indefinite number of times—success is tolerably certain to be finally obtained; but in exhibiting delicate experiments before an audience, one is working under the most unfavourable conditions, and, in case of failure in the first instance, the attempt cannot generally be repeated. Moreover, the substance with which we are chiefly concerned, selenium, is apparently extremely capricious in its behaviour. This appearance is, of course, really due to our present ignorance of its properties; but the fact remains that, on account of the great uncertainty of its action, it is a very difficult substance to deal with.

Selenium is a rare chemical element which was discovered in the beginning of the present century. In many of its properties it closely resembles sulphur, and, like sulphur and some other substances, it is capable of existing in more than one form.

The ordinary form is that called vitreous. Selenium in this condition is as absolutely structureless as glass, and in appearance resembles nothing so much as bright black sealing-wax, with, perhaps, somewhat of a metallic lustre; its real colour, however, when seen in thin films, is ruby red. Its melting-point is a little higher than 100° C. In its second modification selenium is crystalline. When in this form its surface is dull, its fracture is metallic (not unlike that of cast-iron), its colour is grey or leaden, and it is quite opaque to light; its melting-point also is considerably higher, being 217° C.

Vitreous selenium, if melted and kept for a certain length of time at a temperature between its own fusing-point and that of crystalline selenium, will crystallise; and I think I am right in saying, from casual observation, though I have made no experiments to verify the point, that the length of time necessary for crystallisation depends upon the degree of temperature, being proportionately shorter as the temperature approaches 217° C.

Vitreous selenium is an exceedingly bad conductor of electricity; it is, indeed, an almost perfect insulator. Crystalline selenium is a moderately good conductor, and it possesses this very remarkable property, which has been utilised in the photophone and other inventions, that it conducts better in the light than in the dark, the change in its resistance to the passage of a current of electricity through it varying, according to Professor W. G. Adams, as the square root of the illuminating power.

Let a galvanometer be connected to the two poles of a battery by means of two copper wires. The passage of a current of electricity will at once be denoted by the deflection of the magnetic needle; or, if a little mirror is attached to the needle, and a beam of light be reflected from it upon a scale, the movement of the spot of light will indicate the movement of the needle. Let, now, one of the wires be cut, and the two ends be joined together by a piece of crystalline selenium. The spot of light will again move, but its deflection will be very much less than it was before, showing that the resistance of the selenium is very much greater than that of the wire. Moreover, if the piece of selenium be alternately exposed to and screened from a beam of light, the deflection will be greater when it is in the light than when it is in the dark, showing a corresponding variation in its resistance. This remarkable property of selenium was first announced and exhibited by Mr. Willoughby Smith in 1873. But the effects produced by the simple arrangement which I have just described are small, and very delicate instruments are required for their observation.

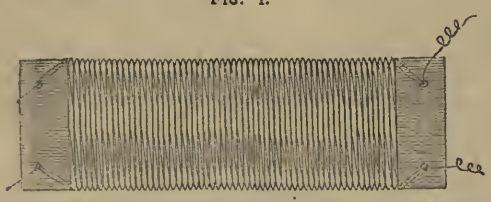
Since that date several devices have been proposed for exaggerating the effect, but they all depend upon the fact that the amount of the variation increases with the extent of the selenium surface acted upon. It has lately been the fashion to call these arrangements "cells," which, in most cases at all events, seems to be a very inappropriate name. It has been suggested that they should be termed "rheostats," a name which well expresses the purposes for which they are generally used, and is less likely to lead to confusion than the other. In deference to custom, however, I shall call them by the usual name.

The simplest selenium cell which could be devised would be made by placing two short pieces of copper wire parlalel to each other, and very near together, and con-

* A Paper read before the Royal Institution of Great Britain, Friday, March 11, 1881.

necting them by a narrow strip of selenium. The effect produced by light is increased by lengthening this arrangement. We might go on increasing the wires with advantage until they were 10 or 12 feet long or more, every additional inch of length producing an increase of "sensitiveness" as it is called. But a cell of this length would be cumbersome and unwieldy to use, and in fact could hardly be lifted without being destroyed. Dr. Werner Siemens therefore adopted the device (among others) of coiling up the wires so as to form a double spiral, and thus made a convenient and portable cell of great sensitiveness. But it is very difficult indeed, as I know by experience, to produce these double wire spirals of any considerable size without the two wires touching one another at some point. After many attempts I succeeded in producing spiral cells about $\frac{3}{4}$ inch in diameter, but I found it impossible to exceed this size, and as it was not large enough I adopted a simple and very effective variation of Siemens's method, which I believe has not been previously suggested. A copper wire is wound after the fashion of a flat screw around a narrow slip of mica, the threads of the screw being about 1-16th inch part. Beside this wire, and at a distance of 1-32nd inch from it, a second wire is wound in exactly the same manner, each of its turns coming midway between two consecutive turns of the first. Care is taken that the two wires do not touch each other at any point. Over one surface of the mica a film of melted selenium is spread, and after being worked smooth and uniform it is crystallised. By this means the two wires are connected with each other through half their entire length, by a series of very narrow strips of crystalline selenium.

FIG. 1.



Mica Plate, wound with Two Copper Wires ready for Selenium Coating.

I have here a tiny selenium cell which has been constructed in this manner. Each wire makes about six turns, and the area of the selenium upon its surface is about half that of a threepenny piece, its thickness not much exceeding that of a sheet of ordinary note-paper. Its resistance, though it is very high relatively to that of good conductors, is, compared with anything of the kind that I had ever seen before, remarkably low, and its sensitiveness to light is great. When a bat's-wing gas flame is held at a distance of 3 inches from it, its resistance is less than one-third of that which it measures in the dark. Larger and more carefully constructed cells, of course, show better results. No form, however, that I have tried (and I have made several dozens) has in my hands been superior to that of a double flat screw.

When cells are to be made of any considerable size, the labour of winding on the wires with sufficient regularity is very great. By the help of a lathe this difficulty may be reduced to a minimum. The method of proceeding is this:—A cylinder is turned of hard wood, of length and diameter slightly greater than that of the proposed cell. This cylinder is cut longitudinally into two equal parts, and between the two semi-cylinders thus formed a slip of mica is placed sandwich-like. The ends are secured with screws, and the whole is smoothed down in the lathe. When the edges of the mica are quite flush with the surface of the wood, a screw of from thirty to forty threads to the inch is cut upon the cylinder. On removing the mica from the wood its two edges are found to be beautifully and regularly notched. The first wire is then wound into alternate notches, and the second into the others.

I will throw upon the screen the image of a slip of mica with the two wires wound upon it, and ready for the reception of the selenium coating. It will be seen that the turns are perfectly regular, and close as the wires are to each other they do not touch at any point. (Fig. 1.)

The next step is to apply the selenium, and to do this properly is an operation which requires a certain amount of practice and patience. The mica is heated to a temperature slightly above 217° C., and melted selenium is spread over its surface as evenly as possible with a metal spatula. The cell is then cooled, and its surface should be smooth and lustrous. Before you is an embryo cell which has reached this stage of its preparation. The selenium being still in the vitreous condition, is a perfect insulator, and when the cell is connected in circuit with a battery and a reflecting galvanometer, the spot of light is found to be absolutely motionless. I now propose to crystallise the selenium in your presence. The mere crystallisation occupies a very short time. It is only necessary to place the cell upon a brass plate, and raise it by means of a Bunsen burner to a temperature somewhat below the fusing-point of crystalline selenium. The method described by Professor Adams in his classical paper published in the *Philosophical Transactions*, is entirely different. He heated a bucket of sand by placing in it a red-hot iron ball. At the expiration of an hour he removed the ball, and placed in the heated sand his pieces of vitreous selenium, wrapped up in paper. After remaining for twenty-four hours, the selenium was generally found to have attained the crystalline form, and the resistance of some of his specimens thus prepared was far lower than that of any which have been made by myself. Their sensitiveness, however, does not appear to have been great. The method of crystallisation which I generally adopt, and which is due to Prof. Graham Bell, has at all events the merits of simplicity and rapidity. In two or three minutes the whole surface of the selenium film becomes dull and slate-coloured, and if, when the cell has attained this condition, it be removed from the hot metal plate, I have little doubt that on testing it with a galvanometer, it will be found to conduct electricity and to be sensitive to light. (Exp.) According to Prof. Graham Bell, nothing more is necessary for obtaining the greatest degree of sensitiveness. The old-fashioned process of long heating and slow cooling may, he says, be altogether dispensed with. In this matter my experience differs entirely from his, for I find that cells which have been kept for some hours at a temperature just below the point of fushion, and then allowed to cool very gradually, are vastly more sensitive to light than those which have not been thus annealed.

The following table shows the resistances in the dark and under different degrees of illumination, of a few cells taken from my stock. The resistance of No. 6, when exposed to a lime light at 10 inches, is less than one-fiftieth of its resistance in the dark.

Resistances in Ohms.

Cell No.	In Dark.	Gas Jet at 12 Inches.	Gas Jet at 6 Inches.	Gas Jet at 3 Inches.	Lime Light at 10 inches.
4	400,000	190,000	150,000	80,000	
6	250,000	80,000	54,000	29,000	5,700
7	430,000	160,000	110,000	64,000	With Alum Cell.
9	87,000	52,000	42,000	33,000	
10	62,000	32,000	26,000	17,000	14,000
11	100,000	63,000	50,000	33,000	24,000
12	22,700	9,100	6,600	4,500	—

It is an interesting question, which of the coloured components of white light has the greatest power in effecting these changes in the resistance of selenium; or, again, whether the effect is produced by light at all, or is due simply to heat. Captain Sale came to the conclusion, on moving a piece of selenium through the solar spectrum, that the maximum effect was produced at or just outside the extreme end of the red, at a point nearly coinciding with the maximum of the heat rays. Prof. Adams per-

formed the same experiment with the spectrum both of the sun and of the electric light, and found that the action on the selenium was greatest "in the greenish yellow and in the red portions of the spectrum." The greenish yellow is the point of maximum illumination, which is a remarkable fact; but his words seem to imply that there was a second maximum in the red. The violet and the ultra-violet rays, he says, produced very little, if any, effect. In consequence of the discrepancies in these results, I determined to repeat the experiment for myself. The source of light which I used in the first instance was an oxy-hydrogen lime light, and the spectrum was formed with a bisulphide of carbon prism. The experiment was repeated six times, and three different selenium cells were used. The results were precisely the same in every case, and proved in the most marked manner that the greatest influence occurred in the boundary-line between the red and the orange; thus differing completely from the results obtained both by Capt. Sale and by Prof. Adams. Moreover, the resistance when the selenium cells were placed in the ultra-red, 2 inches beyond the limits of the visible spectrum, was in every case lower than when it was in the blue, indigo, and violet. But even in the ultra-violet the resistance of the cells was lower than when they were quite removed from the spectrum.

My friends, Mr. Preece and Mr. W. H. Coffin, who were present during these experiments, suggested that it would be desirable to vary them by making use of different sources of light, and different methods of dispersion; and a few days afterwards, by the great kindness of Mr. Norman Lockyer, they were repeated in Mr. Lockyer's laboratory by Mr. Preece and myself with the electric light and a magnificent diffraction grating. Nine experiments were made with three cells, and the results were as absolutely concordant as those which we had previously obtained; but they all concurred in placing the maximum at the extreme edge of the red, thus agreeing with Captain Sale's observations. One other remarkable effect must be noticed. In the case of a single cell—that which I distinguish as No. 6—with which three experiments were made, a second maximum was observed in every case in the greenish yellow, though the effect was about 20 per cent smaller than at the extreme red. The electric light, however, is from its great unsteadiness most unsuitable for experiments of this nature, and since no such exceptional phenomenon was ever observed before or since, I am inclined to believe that, by a coincidence which, however remarkable, is by no means impossible, the light happened to be unusually intense just on the three occasions when this particular cell was in the greenish yellow. A third series of experiments made with a gas flame and a bisulphide of carbon prism agreed with the first in placing the maximum at the orange end of the red. Many more combinations of sources of light and dispersion remain to be tried, but time for these and for innumerable other experiments which have suggested themselves has hitherto been wanting: for an operation which may be described in a dozen words not unfrequently requires as many hours for its performance.

(To be continued.)

NOTE ON THE SPECTRUM OF SODIUM.*

By CAPTAIN ABNEY, R.E., F.R.S.

On examining the spectra of different metals, there is one point which is striking in the extreme, viz., the absence of any very marked lines in the region between λ 7000 and λ 7600, which latter number we may take as the visible limit of the spectrum. With the exemption of the well-known pair of lines of potassium I am not aware that any lines in spectra, which have been carefully studied, have been found below this limit, though recently in the spectra of some of the rarer earths some few lines have been recorded. Having photographed the bright line arc spectra of several metals, it appears, so far as examination has been made, that only those which can be volatilised at a low temperature have any lines in the ultra-red.

Sodium is an example of this. It has a pair of lines at wave length of about 8187 and 8199 of an intensity of about 3, taking the intensity of D lines as 10. It will be noted the difference in wave-length between this pair is greater than that of the D lines. They do not seem to have any corresponding dark lines in the solar spectrum, though there are three faint lines which lie close to that wave-length.

In the calcium spectrum there are a pair of very faint lines which lie between λ 8500 and 8600. These exact wave-lengths have not at present been determined.

Iron, cobalt, nickel, copper, magnesium, and potassium have, up to the present, given negative results, but will be examined again.

* A Paper read before the Royal Society, June 16, 1881.

ON THE ABSORPTION OF GASES BY SOLIDS.*

By J. B. HANNAY, F.R.S.E., F.C.S.

During the progress of the investigations which I have from time to time had the honour of bringing under the notice of the Royal Society, I have again and again noticed the apparent disappearance of gases inclosed in vessels of various materials when the disappearance could not be accounted for upon the assumption of ordinary leakage. After a careful examination of the subject I found that the solids absorbed or dissolved the gases, giving rise to a striking example of the fixation of a gas in a solid without chemical action.

In carrying out that most troublesome investigation, the crystalline separation of carbon from its compounds, the tubes used for experiment have been in nine cases out of ten found to be empty on opening them, and in most cases a careful testing by hydraulic press showed no leakage. The gases seemed to go through the solid iron, although it was 2 inches thick. A series of experiments with various linings were tried. The tube was electro-plated with copper, silver, and gold, but with no greater success. Siliceous linings were tried—fusible enamels and glass—but still the tubes refuse to hold the contents. Out of thirty-four experiments made since my last results were published, only four contained any liquid or condensed gaseous matter after the furnacing. I became convinced that the solid matter at the very high pressure and temperature used must be pervious to gases. This I find to be the case, and to a very remarkable extent. I am still investigating this matter, but as I have so much on hand it may be some time before I can finish the work, so I wish to place on record the results so far as I have proceeded. I find that glass, when at a temperature of about 200°, absorbs a large quantity of gas when the latter is under a pressure of 200 atmospheres. Oxygen and carbon dioxide have been used, and have been found to be largely absorbed, and on cooling the glass under pressure the gas is retained permanently fixed. So much is absorbed that, on quickly raising the temperature to the softening temperature of the glass, the sudden escape of gas drives the glass into foam. On slowly raising the temperature and retaining it at 300°, most of the absorbed gas is given off without any visible action.

The frothing up of the glass by the outrush of gas is very striking. Other silicates, and also borates and phosphates, absorb gas, especially carbon dioxide, under great pressure. Metals absorb hydrogen and some of its compounds with carbon. As the treatment of quantities of matter sufficient for analysis at these high pressures and temperatures is a matter of great difficulty, the majority of experiments being failures, the work proceeds

* A Paper read before the Royal Society, June 16, 1881.

but slowly; but I hope during the summer and autumn to be able to elucidate the subject quantitatively, when I shall detail the results to the Society.

ESTIMATION OF CARBONIC ACID.

By T. S. GLADDING.

The following apparatus for the estimation of CO_2 by absorption has been used in our laboratory for several years, and has proved itself indispensable on account of its great convenience and accuracy.

It consists of the ordinary generating flask, followed by an empty U-tube, to retain condensed water-vapour; this is succeeded by four potash bulbs of the Geissler form. The first of these contains concentrated H_2SO_4 to dry the gas. The next two contain potash solution, of sp. gr. 1·27, for absorbing the CO_2; the last contains concentrated H_2SO_4 to absorb the moisture taken up from the potash solution. Then comes a U-tube containing soda-lime and serving as a guard.

The last three Geissler bulbs constitute the weighable portion of the apparatus. Perfectly dry air, plus CO_2, enters these and perfectly dry air alone escapes. The increase in weight gives the amount of CO_2.

The advantages of this apparatus are:—

1. The superiority of concentrated H_2SO_4 over $CaCl_2$ as a drying agent on account of (*a*) its greater thoroughness; (*b*) its non-absorption of CO_2, as is the case with $CaCl_2$, requiring its previous saturation by a current of the gas; and (*c*) its greater cleanliness and simplicity of renewal, which takes but a moment, and is necessary only at long intervals.

2. The rapidity with which an analysis may be made. The bubbles of gas may pass at the rate of five per second with perfect safety, and an analysis including all weighings, and a final aspiration of four or five litres of air be completed in less than two hours.

3. The large quantities of substance that may be used and the consequent increase of accuracy attained. Five grms. of bicarbonate of soda may be used as safely as one grm. in the old form, and duplicates easily agree within a few hundredths of a per cent. An analysis of Iceland spar, taking 5 grms., gave 43·97 per cent.

A strong aspiration must be maintained from the beginning of the analysis, the flow of gas being regulated by a screw-clamp placed before the generating flask. 100 c.c. of water are added to the carbonate, and then normal HCl to slight excess. Not a trace of HCl is carried over on boiling. All the corks are of soft rubber, and black rubber tubing is employed for connections.

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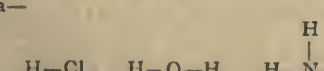
CHEMICAL AFFINITY AND ATOMICITY.*

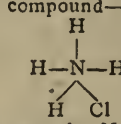
By WILLIAM DURHAM, F.R.S.E.

Though the theory of "valency" or "atomicity" has done good service to chemistry, and clearly enough explains many chemical combinations, yet it is very generally admitted that it is defective and fails to account for many observed facts. In this theory, hydrogen being taken as possessing unit of valency, the elements are divided into groups according as they combine with one, two, or more atoms of hydrogen, or other similar element, and are classed as monatomic, diatomic, &c., or shortly, monads, dyads, &c. This arrangement may be illustrated by such compounds as hydrochloric acid, water, and ammonia—



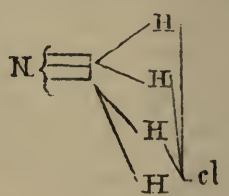
where hydrogen and chlorine are monads, oxygen a dyad, and nitrogen a triad. There are many examples, however, of elements of one class acting as if they belonged to another. Cl, for example, a well established monad, forms with silver, Ag, another monad, a compound, Cl_2Ag_4, in which both cannot be monads. With this latter element, Ag, oxygen forms a compound, OAg_4, in which the oxygen must act as a tetrad. Nitrogen forms NH_4Cl, in which it appears to act as a pentad and so on. Then, again, there are whole series of compounds of which no satisfactory account can be given, such as the double chlorides, $PtCl_42KCl$, $PtCl_42NaCl6H_2O$. In the former of these we have one tetrad atom united to eight monads, and in the latter, in addition to this, there are six molecules of water fixed on. Many other cases, equally difficult of explanation, might be given. Various hypotheses have been brought forward to account for these anomalies, none of which seem to me satisfactory.

The whole difficulty seems to be in the assumption that chemical affinity acts in atomic indivisible units. Because matter is atomic in its structure it seems to have been assumed that the chemical affinity associated with these atoms must also act as an indivisible unit. Let us take a simple case: nitrogen, usually considered a triad, forms, as we have seen, the compound—

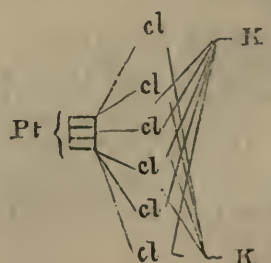


in which it acts as a pentad. Now, in this formula this difficulty at once presents itself. We have here chlorine, which usually has such an intense affinity for hydrogen and such a weak affinity for nitrogen, represented as directing all its energy towards the nitrogen and having no effect on the hydrogen whatever, and this, too, when in such close contact as the atoms must be in a molecular state.

Now, let us get rid of this idea of affinity acting in an atomic fashion. Suppose chlorine to have affinity equal to one and nitrogen equal to three, but capable of being spread out, and see how the compound would be represented. We should have the nitrogen spreading out its affinity over the 4 atoms of hydrogen, giving, *on the average*, ¾ to each; similarly, the chlorine would give ¼ to each. Therefore the whole affinity acting on each atom of hydrogen would be $\frac{3}{4}+\frac{1}{4}=1$; conversely, the nitrogen would be acted upon by affinity $=3$, and the chlorine by 1, and the whole molecule would be bound together thus—



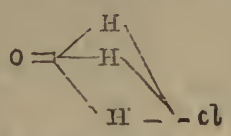
Probably, also, the chlorine would act on the nitrogen, and *vice versa* to a small extent. This principle, applied to the other difficulties, gives the key to unlock all; thus the double chloride of platinum and potassium would be represented by—



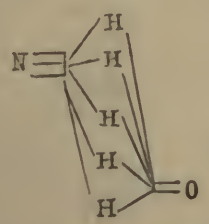
* Abstract of a paper read before the Royal Society of Edinburgh.

Water of crystallisation, &c., it is evident, could be represented by the same means.

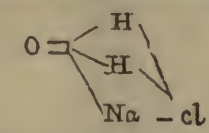
Then, again, the affinity may act, not in increasing the number of atoms taken up, but in the intensity of the combination. Thus, in the carbon compounds, where every addition of CH_2 increases the boiling-point and density, the affinity = 2 added by every such increase spreading itself over the whole hydrogen atoms, increases the intensity of the action, and draws the whole molecule closer together. This does not exclude the idea of the carbon atoms acting on one another also. If this spreading action of affinity be admitted we may go a step further. Let us take hydrochloric acid in water, which comes very nearly to what is called a chemical compound, but not quite. Suppose we represent a molecule of each, connected thus—



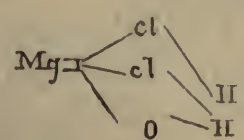
Now, this compound does not exist, because the energy of combination is not strong enough; but suppose we surround the HCl with numerous molecules of water, H_2O, all acting upon it as represented above, it is manifest it would reach a point when the HCl would be firmly held by the water, and, conversely, the water by the HCl. On the one side of this point, HCl would tend to escape, and on the other side, water, which we find from experiment actually to be the case. Ammonia gas might be represented similarly—



dissolved in water. Carrying this idea still further we might represent solutions pure and simple in the same way. Thus, common salt in water would be—



That this action is not fanciful we may see from the behaviour of magnesium chloride, $MgCl_2$. This salt dissolves readily in water, but cannot be recovered by evaporation, because it obstinately retains the last traces of water, until at length mutual decomposition takes place, and HCl is liberated, while MgO remains. Now this evidently arises from the great affinity of Mg for O and of Cl for H, as the formula indicates—



Why not then conclude that this is the explanation of solubility, which just means adding more water. This also explains the solubility of the salts of the alkaline metals, as they all have intense affinity for oxygen, and it is significant that the chlorides which are not soluble in water, viz., those of silver, mercury, and lead, are those metals which have least affinity for oxygen.

Many other phenomena may be explained on the same principle, such, for instance, as the effects of dilution on chemical action, alloys, solution and occlusion of gases. The phenomena of electrolysis and dissociation support this principle also. There are some physical facts also on which this view of chemical action may throw some light. According to Regnault, gaseous volume diminishes exactly as the pressure increases; then gradually there is a slight inequality, indicating an attraction between the molecules of the gas; then, again, this attraction becomes changed into a repelling action. Now, suppose the molecules of gas, brought sufficiently near to allow their affinities to act, we should have, according to my idea, a separation of the atoms of the molecules and a drawing together of the molecules. Suppose the gas was CO, then the carbon of one molecule would attract the oxygen of its neighbour, and conversely, this would produce attraction, until all the atoms of O and C were at equal distances, when there would be no tendency to draw closer; in fact, they would be at molecular distances under the circumstances of pressure, &c. Now, if we assume that the motion in a molecule is revolution round a centre, and if we also assume that affinity varies with distance as gravity does, then we can easily understand where the repulsion comes from. As all the atoms revolve round a centre by compression we increase their angular velocity, and by this means we increase also their centrifugal force at a greater rate than the affinity increases, and hence the tendency to fly out. Andrews's critical point may be explained in the same way. As long as the temperature is above a certain point, increasing the pressure only increases the angular velocity, but as the temperature diminishes the affinity at length is strong enough to establish a new position of equilibrium.

It appears to me, therefore, if we get rid of the idea of chemical affinity acting in an atomic indivisible manner, we are enabled to explain many difficulties, and to arrange in one graduated series many phenomena, hitherto considered distinct, and to establish a chemical continuity in harmony with what we find in all the other operations of nature.

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,
Member of the American Society of Civil Engineers.

(Continued from vol. xliii., p. 287.)

IN the arrangement of ventilating and heating apparatus for Halls of Audience upon the foregoing type, a few figures of proportions required may here be stated:

It having been accepted what number of people are to occupy a certain hall—taking the maximum number—the total quantity of air needed each minute will be derived by a simple multiplication of this number by the quantity per person, per minute, which the occupancy of the hall demands. That is, for a hall occupied by occasional sessions of one or one and a half hours, say ten feet, while for a legislative hall for frequent long sessions, thirty feet may not be too large, while proper judgment should determine intermediate values for other conditions of occupancy. The figures of total quantity of air needed each minute being determined, the sectional area of the duct, near the fan, is got by dividing this figure by 600.†

* A Paper presented to the American Society of Civil Engineers, January 26, 1881.

† 600 feet having been stated previously as the desirable rate of flow of a forced current in a duct per minute.

Now, this area is simply that of the periphery of the fan multiplied by its width, and as the width of the single fan at the periphery is =one-tenth diameter, it follows that the area of outlet is $=\pi D$ (=circumference), multiplied by $\frac{1}{10}$th D (=width) $=\pi D^2$ divided by ten. Taking the value of π (=ratio of circumference to diameter); making the division, and extracting the square root from the figures given, it follows that D (=the diameter of the proposed fan) =0·073 times the square root of the number of feet of air to be moved each minute. This rule can be expressed more simply in algebraic characters, as follows:—

$$Nq=Q;\ \frac{Q}{600}=\frac{\pi D^2}{10}$$

Where N=maximum number of persons to be supplied with air for ventilation.

„ q=least quantity of air per person, per minute, in cubic feet.

„ Q=total quantity of air to be supplied, or the least quantity in cold weather, also in cubic feet.

„ $\frac{Q}{600}$ =sectional area of duct near fan, in square feet.

„ D=diameter of single fan, that is of a fan which carries its blades and receives its air on one side only, in lineal feet.

„ π=ratio of circumference to diameter.

Reducing the above equation to give the value of D, then:—

$$D=0{\cdot}073\sqrt{Q},\text{ nearly,}$$

and for a double fan or one receiving its air on both sides, then:—

$$\mathfrak{D}=0{\cdot}053\sqrt{Q},\text{ nearly.}$$

When $\mathfrak{D}$=diameter of double fan, or of one carrying blades and receiving air on both sides of the discs, in lineal feet.

The inlet or suction air duct or passage to a fan should have, as an absolute necessity to supply the air, 1·4 times the area of the outlet or distributing duct. To compensate for resistance of air in passage along the ducts, and yet to preserve the smallest efficient areas of distributing ducts and branches, the sectional area of such distributing ducts or branches, at any given distance from the fan, should be increased over what is derived from

$$\frac{Q}{600},$$

by adding 0·0025 times ($\frac{1}{400}$) for each foot of distance, and there is required a constant addition of 0·25 ($\frac{1}{4}$) a square foot, which becomes a necessity to meet the great resistance of small passages. The area of a main duct at any given distance from the fan should be formed by computing after this method—the area of *each* branch, which may be considered as *trumpet shaped or expanding from* the fan to the point of bifurcation (from which point the *branch* may be deemed parallel), and this area is to be used when summing up an aggregate of total area of cross sections at such distance.

It may be needful to call attention of those who may plan a ventilating apparatus, that the air-ducts must be exclusively devoted to their purposes and should not be used, or even made so as to be available for passages. They may be employed for the lines of supply or return mains or distributing pipes, but the ducts should not be encroached upon by coil chambers constructed within them. Clear, unobstructed, smooth passages, with all angles rounded and all corners filled in, and all enlargement avoided, should present the least of resistance to the flow of air.

The foregoing formidable array of rules and data have been presented of necessity, for guidance in construction. They represent absolute and unalterable conditions in forced ventilation, and will enable any one to design, without mistake, when engaged in making original plans. It may be objected that the dimensions of ducts obtained by these rules are excessive, nearly to the point of impracticability, but in reply to this it must be stated that they (the dimensions) are less *by one-half* than can be employed for ventilating by heated currents alone (which is cold weather ventilation only), or for ventilating by exhaust shafts, heated in same way to induce currents (which is closed window ventilation). The frequent assertion of success of self-acting (as they are called) ventilating apparatus, often confutes itself, when the incompatibility of size of ducts is investigated.

As to the methods of distribution of currents from the branch ducts within a hall, and amongst an audience, the subject would call for longer discussion than there is room now to consider. It will only be said that at the mouth of discharge of each branch, baffling boxes must be arranged and provided, so that the efflux shall take place from an extended surface, at a not greater velocity, within one foot of the surface, than two feet per second; a condition which calls for the area of surface to be ten times as great as the sectional area of the branches. And it is further required that the direction of afflux should be *upward* in general, or when horizontal it should meet some other current of afflux near by, and be directed upwards. The augmented current of afflux in horizontal directions, as in the risers of the seats or steps, of an amphitheatre, is sure to engender local currents of much greater intensity than the original ones, and to become seriously objectional to an audience.

Whatever be the dimensions given to the supply ducts and passages, it must be remembered that those for removal of air must have adequate size, and if economy in the impelling force be studied, must be at least of equal dimension. In cold weather, with a high building—and all buildings are more or less high—the labour to be performed by any ventilating appliance in inducing a flow of air is materially reduced by the ascensive force of the columns of hot air in the building. As the weather becomes warmer, more and more motive-power is demanded to impel the current, but whatever motive power be expended, the movement of any quantity of air will cost in motive-power as the square of the velocity. The supposition of any change in sectional areas (omitting some frictional considerations), which shall reduce them below the area accepted as the least at the fan, admits of a reduction of the fan itself to conform.

A thoroughly arranged ventilating apparatus calls for distributed removal of air as positively as it does for distributed supply, and for complete efficiency, all flues and branches of efflux should have, after providing the branches, similar baffling mouths to those described at mouth of entry, 1·4 times the area of the supply flues and branches.

With a forced ventilation, these flues should not have that compensation in reduced area, as they become high, which is essential to self-acting hot air shafts. The condition of ventilation assumed, supposes the expulsion of larger quantities of air, as the relative temperature inside and out, becomes more equal, and at the point of equality, the value of the height of the building as a shaft becomes nothing,

This large size of flues of efflux opens another source of trouble. It is almost indispensable that all the eduction flues shall be gathered into one single main flue, with judicious arrangement of the branches at their points of junction, so that they shall *direct* themselves into the general current of effluent air, and entirely and completely fill the great flue or shaft, thus preventing any eddies or back currents from establishing themselves, from room to room, from one part of a room to another; or worse yet, from the outer air down one side of a main shaft and up the other. With numerous ventilating flues or chimneys to open fire-places in any one building, whether supplied with air by forced ventilation, or by any other ventilation, or if unsupplied with air altogether, but merely furnished with *ventilating flues*, or yet again, where numerous

chimneys only exist, *the chance for a down draft* for some of them goes beyond the theory of chances, and becomes a certainty.

At all events, for a hall, the ventilating branches must be gathered into one general eduction shaft, while it may be possible for separate rooms to have separate independent ventilating flues, with a little possibility of most of them working the right way, if the weather is not very cold.

A few figures of the proportions of steam heating apparatus, in combination with ventilating, may be given. In most buildings to be ventilated as halls there will be found rooms and passages, whose requirements in occupancy will demand a much less liberal supply of air than the halls, or sessions rooms themselves.

The quantity of air supply to such buildings will be derived from two systems, whilst additional heating capability will be required from a third system. The system dependent upon ventilation of session, audience, or largely occupied rooms, has been discussed already, but the least quantity for occasionally occupied rooms is much in excess of what is needed, where the heated air is made merely the vehicle for transporting heat to a room to be warmed. The temperature of currents for ventilation solely, can scarcely exceed 70 to 80 degrees in the coldest weather in the most exposed hall, while rooms warmed more economically with smaller quantities of air, may have hot air currents of perhaps 110 degrees from steam heated surfaces. In the second case, the volume of air requisite will be found by deciding on the extent of heating surface for a given room of given exposure of outer wall, and position in the building. This extent of heating surface may vary from 1 square foot to 40 cubic feet of space in the room, to one square foot to 120 cubic feet of space in the room. The latter value representing a room of ordinary living size, with the least usual wall or window surface, sheltered from cold winds, and in the second story of a warmed building; while the former value is that of the exceptional case of great exposure, or of situation on the ground floor of the building. When an allowance for these circumstances has been made, and the quantity of heating surface needed for heating any room by indirect heating (as it is termed), has been reached, it may be accepted that 3 cubic feet of air per minute must be given to each square foot of heating surface, as the greatest quantity when the thermometer is at zero, at such time as the least supply for ventilation is supposed. A square foot of steam heating surface, with steam at 30 to 40 pounds pressure may be taken, *if well exposed*, to be capable of heating 3 cubic feet of air from zero to 100 degrees, or 5 cubic feet of air from 50 degrees to 70 degrees (or 80 degrees) in a minute.

It will be noticed that the heating capabilities of surfaces is referred to the cubic space in the building. The great loss or transfer of heat in any building takes place at the windows, so great that the computation might almost be confined to their surface as a unit to estimate on, and the surface of the walls or the cubic contents of the rooms be neglected. But, on the other hand, it is the *exposure* of the window which becomes of most account, and that has to be allowed for by judgment, and not by estimate; and with *exposure* a wall may become, if thin or thick, a material element in consideration.

Finally, the windows do bear a definite proportion to cubic space; or, if they do not bear the usual proportion, they may be *allowed* for; until the skill in guessing comes back to a guess based on cubic contents, as equally valid with one based on window surface.

The third system of steam heating which finds examples in all large buildings—in passages, at or near doorways, or invariably somewhere—is direct heating by coils placed in the rooms to be heated. For this method there is demanded 1 square foot of heating surface for each 80 cubic feet of space within the walls of an exposed room, or of a room where the heating is demanded at short notice; as in an office which is allowed to become cold at night. While 1 square foot of direct heating surface is ample to warm 200 cubic feet of space continuously, without intermission day or night, special demands to heat doorways and open passages must be estimated on special grounds.

For heating in chambers with indirect heating (ventilation) box coils, as they are denominated, are best, while for office heating, vertical coils are decidedly preferable, although their surface is not so effective as that of horizontal pipe coils by about 20 per cent.

The main pipes for steam and return connections, by branch or direct mains to each cluster, coil, or radiator, should have the equivalent of 1 circular inch of sectional area for steam (or flow) connections (equal to 1 inch steam pipe nearly) for every 500 square feet of effective steam surface, augmented or enlarged 0·0025 ($\frac{1}{400}$) times for each foot from the point of first distribution or branch from the main. The condense water or return connection will follow the same rule, with the equivalent of $\frac{1}{4}$ a circular inch for the same surface (equal to a $\frac{3}{4}$-inch pipe nearly). The aggregated area of great mains need not be so large as would follow from aggregating the branches, but should be increased in size up to the point of any branch, as if the enlargement of that branch, for distance, occurred at the point of branching, and not at the coil or heating surface. This rule will, if carefully read, prove easy to apply.

Flow mains should rise to some point (where they can be trapped or drained), vertically, and then have a descent of a $\frac{1}{4}$-inch in 10 feet, regularly, to the end. If circumstances do not allow this, steps of vertical rises, well trapped, should be succeeded by lines of descending grade. The return main should have a corresponding fall towards the boiler, or other condense water recipient.

Boilers of the common tubular form require about 1 square foot of boiler surface (reckoning all the surface, of whatever kind, exposed to the fire or to the gases of combustion, between the grate and the boiler chimney) to each 9 square feet of heating surface in coils or radiators.

The grates of such boilers should have 1 square foot of surface to about 30 square feet of boiler heating surface. These ratios give 1 square foot of grate to 270 of radiating surface.

The chimney flues for the boilers (the stack) demand a sectional area from one-tenth of the grate surface, for chimneys of 50 feet high, to one-twelfth of the grate surface for chimneys of 100 feet high. These last dimensions are smaller than customary, but sufficiently large if no further requirement will ever be put on the apparatus.

The maximum quantity of coal to be consumed on these grates will not exceed 8 pounds per square foot of grate per hour, while the average quantity will not be over 20 to 30 pounds of coal per square foot of grate in 24 hours for 6 months of a year. A fan delivering 20,000 to 40,000 cubic feet of air per minute, will demand from 20 to 60lbs. of coal per hour to supply steam, as a rough estimate.

In planning boilers, it is usual to allow one extra boiler for contingencies. There is no necessity to estimate on the supply of steam for the power needed to impel the fan, where buildings are warmed and ventilated, as the exhaust steam of the engine should be utilized for heating purposes, and little extra steam is demanded for this purpose of driving the fan, so little, that the quantity may be neglected in the total of allowances for successful warming.

Further discussion might be had nto the mechanical details, constructively, or as to either their ratios to the great units of individuals to be supplied with air for ventilation, or of cubic space in buildings; of some possible interest to the construction of apparatus; but my purpose has been only to give such figures and data as are indispensable for arranging the ventilation of halls of audience. Every word of superfluous description, and each extra figure, has been carefully eliminated with the sole view of making this information complete in its ostensible direction. The paper, however, cannot properly be concluded except by calling attention to some

requirements, that seem not to have heretofore been adverted to by other writers, but which really control the working of any apparatus, for either warming or ventilating, or both, and which call for modifications in arrangement and construction, almost amounting to a novel system.

The temperature of steam heated surfaces, for steam of such pressure as is usually carried in heating apparatuses, where the boilers furnish steam for running the fan engine, that is at 40 to 60 pounds pressure, will run from 290 degrees to 310 degrees; and these temperatures are practically uncontrollable whenever the steam is admitted to any coil or radiator; so that the external surface of the coil or radiator in air is sensibly the same, 290 degrees to 310 degrees. Some slight but unreliable reduction of temperature in the steam may be had by throttling the supply pipe, but this method becomes especially unreliable when the condensed water is returned, without trapping, at the same pressure, to the boiler. Coils give off heat determinedly until the last moment of being shut off. They fill with water, and becomes very noisy with water hammers; when a small volume of steam in some way is interposed between two columns of cooled water that instantaneously condenses it and forms a vacuum, bringing such columns into solid contact with each other. In exposed places throttled coils freeze up. The nicest adjustment may secure the end of lower temperatures of surfaces, and corresponding lower temperatures of air currents passing them; or of desired constant temperature of air current, obtained by giving less heat to a warmer entering air; but the least change of boiler pressure disturbs it all; in a moment the coil is virulently active with heat, or obstinately passive by water clogging.

There are two methods of meeting this difficulty. The first is the division of a coil into sections, so that one or more of the sections can be employed in heating or be shut off at will.* Some person in control of the apparatus, or at least of the coil for heating, will thus have the means at his disposal to produce any wished for temperature, down to the temperature of the outer air. The second method is found in passing around the coil, unwarmed, such part of the current of entering air as will reduce or temper down that remainder of the current which is permitted to pass through the coil, and is heated by contact with the heated surfaces. A comparatively simple arrangement of the casing of the coil, with register or louvre (blind) valves, and some baffling contrivance to secure the admixture of the two currents, is the mechanism of this method, which, as a method, is nearly as efficient as the former one.† In one essential regard it is more efficient, that is, the by-passing method gives an instantaneous change of temperature of the air delivered in the rooms, while the sectional method calls for time to elapse until the closed-off sections shall have lost their heat, or the newly opened ones increased in temperature, before any effect is produced on the temperature of the air.

It now becomes proper to remark upon the great general cause of failure of the well planned, thoroughly constructed, and entirely controllable apparatuses for heating and ventilating. Anomalous or paradoxical as it may sound, it is a fact, that the most complete apparatus may be the *most* perfect failure. Every improvement in mechanism may have been schemed; every contingency of working may be adequately provided against, and yet the accomplishment, in warming and ventilation, will have resulted disastrously. The fact is certain, and to what fundamental error can it be ascribed? The mistake can, in my mind, be traced to the assumption, upon which the operating of apparatuses have been universally based, *of control* of the individuals warmed or ventilated, as regards their sensations of comfort, or their requirements for health. The error lies in giving the regulation of temperature to an engineer, or even to a general director (in case of an important building). An engineer may be a thoroughly competent mechanic; even more, he may be well informed in the practice, and possibly in the theory, of heating or ventilating. A director may have the theory and practice of heating and ventilating at his command, and be eminent in science or medicine as well; but from either of these control will be resented, and any effort to enforce needful authority will be thwarted. If this be the condition of operating an apparatus in competent hands, what happens when those less likely to enforce authority are placed in charge? The usual engineer is a well-taught mechanic, with ability to run and keep in order an engine, to direct the fireman, and possibly able to do his own steam fitting in repairs; one who in the pride he would take in a well kept apparatus, beyond the keeping of which he has no ambition, commands respect in his vocation. For such an engineer the capability cannot be expected which would allow him to direct or deviate when differing requests are made.

(To be continued.)

* In the heating apparatus constructed at the U. S. capital in 1855-6, this method was introduced by Mr. Nason, and the complete control of temperature, in cold weather, for any given supply of air in every room in the building, was given to the engineer or his assistants.

† This arrangement, which was suggested by Mr. Faber do Faur, was introduced in one instance at the U.S. Capital in 1858, and was entirely successful in the attainment of its purpose.

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF CHEMICAL INDUSTRY.

A DINNER in connection with the inauguration of this Institution took place at Cannon Street Hotel, London, on Tuesday evening last, June 28. The chair was occupied by Prof. Roscoe, F.R.S., President of the Society.

The company having dined, the toasts of "Her Majesty, the Queen," and "the Prince and Princess of Wales and the rest of the Royal Family," were proposed successively by the Chairman.

The CHAIRMAN, in submitting the next toast, said:—Gentlemen, I have now the honour of proposing to you the toast of the evening—"The Success of our new Society of Chemical Industry"—(Loud cheers). The proceedings of this day, and especially the numerously attended meeting which I am now addressing, show me—and I think that you will all agree with me—that the success of this new Society is already achieved—(Hear hear). Nor is it unnatural that this should be so, for I think that it is clear that the want of such a Society really exists, and, moreover, that we have hit upon the right time for founding it. We are almost overdone with different societies. Nevertheless, this Society, has, I think, opened out a new and distinct field of action. Scientific chemists have their society, the Chemical Society, of which I have the honour to be the President. There are other societies, such as the Institute of Chemistry, for analytical chemists; but, strange as it might appear, there has hitherto been no association which would bring together, as we in this Society propose to do, all those great industries which depend upon the utilisation of chemical principles. I should have been the last person to be here to-day in the position which I have the honour to hold, if we, in this Society, interfered in the slightest degree with the older and sister society to which I have made reference. There is no reason to believe or to fear that the Chemical Society of London will, in the least, interfere with us, or that we shall in the least degree interfere with them. There is plenty of room for both—(Applause). What we desire to do is to bring together for the purpose of discussion and of social meeting, gentlemen from all parts of this kingdom, and also from the Continent, who are interested in the pursuits in which chemistry is applied to the arts. You have heard from the Report of the Council which has been read that our Society already

numbers in its first months about three hundred members, and, amongst those, are the names, not only of many of the foremost men among the scientific chemists of the country, but also of men eminent in the more special directions of applied chemistry. And not only is this the case with Englishmen, but, as you have heard this morning, we have already on our list some of the most distinguished of those who have made the subject of applied chemistry their study on the Continent. I need only mention the names of Prof. Hofmann of Berlin—(applause)—of Dr. Caro of Mannheim of Dr. Martius of Berlin, and of Prof. Lunge of Zürich, to assure you that our Society is well appreciated on the Continent. With your permission, I should like to be allowed to read a few words of a letter which I have received from the first-named of these gentlemen, Prof. Hofmann, whose name is honoured wherever science, both pure and applied, is recognised. He writes to me as follows:—"I have heard with much pleasure of the Society of Chemical Industry under your auspices. I need not tell you how much I sympathise with this movement. Having had the privilege in early life of associating with many of the leading representatives of chemical industry in Great Britain; remembering as I do, with feelings of sincere gratitude, how often, and how effectually, my scientific labours have been furthered by their liberal assistance; deeply impressed, moreover, with the conviction of the material advantages which are likely to accrue from their alliance, not only to industry and science but to the progress of mankind—I consider it both a duty and a pleasure to join your Society which you have just started, and which, I have no doubt, will soon become a worthy sister of our Chemical Society of London. Will you be so good as to enrol my name in the list of members, and to convey to the Fellows of the Society the expression of my heartfelt wish for the rapid success of the Association"—(Applause). Thus you see that our efforts are appreciated in Germany. I might read you other letters from the gentleman I have mentioned; but I will not detain you with them. Suffice it to say that they all express their great pleasure at hearing that such a society is founded; they all believe that it will be productive of great good, and they have all joined our ranks with pleasure. It has been well said by Lord Derby, who, when he says anything, always says it well, that "the rule of thumb is dead"—(hear, hear)—and that we are standing at its grave. Well, gentlemen, if the rule of thumb is dead, I suppose that some other rule has been born to take its place; and I presume that the only one that can take the place of the rule of thumb is the rule of head. Now, it appears to me that in this rule of head, or of knowledge, or of science, which is coming forward, our society has a great field which it may now very opportunely occupy. Not only is our society founded for the purpose of bringing together those who are interested specially in the application of the sciences; but, as is evident from the position which I have the honour to occupy, it is your intention to endeavour to bring more closely together the bonds which unite applied with pure science—(Applause). This appears to me likely to produce a fruitful union. I believe that our society has a very important part to play, and that we shall find that year by year as our gatherings go on that the importance of our society is more generally felt, and that the recognition of it increases. I have much pleasure in proposing "The Success of our Society," and coupling with this toast a gentleman whose name is one of the pillars of the state of applied chemistry, for I need scarcely say that the name of Muspratt is one of the oldest and most respected in the chemical history of this or any other country. I have much pleasure in proposing this toast, and in coupling with it the name of Mr. E. R. Muspratt.

Mr. Edmund R. Muspratt replied as follows:—Mr. Chairman and gentlemen of the Society of Chemical Industry, when I entered this room I did not think that I should have the honour of responding to this toast. At the same time I feel very much the honour that you have done me. The President has called to your attention the fact that there already exist in this city two societies for the promotion of chemistry—the one the Chemical Society, and the other the Institute of Chemistry. This shows a very different state of things from that which existed at the time when my old teacher and revered friend, Baron Liebig, came to this country. He often used to tell the story of how when he came to England he found that every one associated the name of chemist with a little boy in a white apron smelling of castor oil. The very fact of our having already those two societies and of our inaugurating this third society in association with chemistry, shows the great progress we have made since then. I would also call your attention to a remark which was made by Professor Dumas some twenty-five years ago at the Société D'Encouragement of Paris. I came across it when I was over in Paris at the time that the commercial treaty was being negotiated. The French chemists tried to make out that they were very much behind us in England, particularly in the alkali manufacture, and that it was necessary for them to have protection; but I called attention to what had been said by Dumas, a chemist whom they all knew and respected. Speaking specially of chemical science, he said that "science sometimes destroyed the balance of commerce," and I contended that it was by the encouragement of science that the French could maintain a rivalry with us. I am glad to say that they have maintained that rivalry in spite of having done away to a small extent with their prohibitive duties. I think that we may learn that when we are met by hostile tariffs throughout the world, we must not have refuge in the old system of protection, but that we must have refuge in the application of science to our industries. I trust and believe that one of the great functions of this Society will be to promote that application of science to industry which will enable us to compete with all the world. To-day we have had a very interesting meeting. Two very different questions have been brought before us, namely, the alkali and the manufacture of beer. This shows how general the application of chemical science is. We see that chemistry is required in the making of one of the most useful substances for industrial art, and also in the making of one of the most useful foods—for I maintain that good lager beer is a very excellent food—(Cheers). I trust that you will have an equally successful meeting to-morrow, and that we shall have the benefit of a discussion upon the great question of the Patent Laws, because, after all, it is very important that we should understand how far it is desirable that patents should be granted. It is perfectly clear that the granting of a patent is the granting of a monopoly, and a monopoly is, I may say, necessarily an evil, but it is necessary to allow the evil to exist in order to bring forth the inventive powers of man. It is for that reason that in modern times we have altered the Patent laws from what they were originally, when patents were monopolies pure and simple. I trust that to-morrow the Society will be useful in forming public opinion upon the great question of the Patent Laws.

The Chairman—Gentlemen, you are all aware that we are acquainted with a class of chemical compounds which are called molecular compounds. These, though not joined together in the intimate manner in which true chemical compounds—such as our Society, for example—are joined together, still are connected by bonds of amity and of unison. Such is the case with the learned societies. Each one helps the other; and we have on the present occasion the honour of the presence at our table of two Presidents of distinguished scientific societies. One of these is intimately connected with us, even more so than the other. I propose the "Health of the Kindred Societies," and I couple with the toast the name of my distinguished friend on my left, Mr. Thomas Greenish, who is President of a Society very closely allied to ours—the Pharmaceutical Society.

Mr. Thomas Greenish, in reply, said—The President has called upon me this evening to respond for the learned

societies. I fancy that he could have chosen the representative of some society occupying a more exalted position than the Pharmaceutical Society. But it was said by Burke, "I honour the man that loves that little platform on which he exists." If I speak on the present occasion of the Pharmaceutical Society, it is because it is that "little platform" on which I stand, and with which I am connected. Perhaps, Gentlemen, there is no body which takes a more intimate or a livelier interest in this associathan the Pharmaceutical Society—(Hear, hear). That Society and its members are intimately associated with chemistry and chemical industry. In fact no step can be taken in pharmacy without bringing in chemistry, or without some connection with chemical industry. I am sure that the members of the Society to which I belong will wish you every success in this undertaking. In looking over the papers which have been read to-day I saw one on lager beer. It is a large industry in this country; but having myself seen the difference of manufacture between the beer of the Continent and that made in this country, I certainly must give the palm to the beer of the Continent. There is a method in its manufacture which either does not suit the climate of this country or does not suit the palate of the people. But the industry is one which, I think, requires some attention and some advancement in this country. Gentlemen, I am sure that you will be wished by the members of the Society with which I am associated, all that success which your Society deserves.

The Chairman—Gentlemen, the next toast that I have the honour to propose to you is that of "Our Visitors." We have several distinguished gentlemen here present with us this evening. I regret that many of you were unable to be present at our morning meeting; but those gentlemen who had the advantage of being present will not wonder when I say that the President of the Society of Telegraph Engineers is truly and really a member of our Society, we were informed that our chimney tests for hydrochloric acid and other noxious vapours pale and dwindle before the test which the President of the Society of Telegraph Engineers can apply to the same subject. We heard then from Mr. Varley that the non-insulation of the telegraph wires is an excellent and most delicate test for the presence of these noxious vapours. I have great pleasure in coupling with the toast of "Our Visitors" the name of my distinguished friend Professor Carey Foster, the President of the Society of Telegraph Engineers.

Professor Carey Foster—Mr. President and gentlemen, I feel it an extremely great honour to be called upon to reply to the cordial toast which you have drunk to the visitors who have partaken of your kindness this evening. Our President has reminded us of the death of the late potentate, the rule of thumb, and that his lamented decease has rendered it necessary that a successor should be brought to the front. I suppose that we may consider that we are now at a sort of christening feast of the successor, and adopting this view, perhaps it is not quite unfair to take some little interest in the name of this new ruler. The Society of Chemical Industry seems at first sight to be, perhaps, like the name of a foreign society rather than of an English society. We have heard of a Mathematical Society, but never of a Society of Mathematics; we have heard of a Society of Engineers, but never of a Society of Engineering. But I suppose that we may interpret this impersonal form which you have given to the name of your Society as meaning that it is not to be a society for the promotion of the selfish interests of individuals—industrious chemists—but that it is to be a society for the promotion, in a public and liberal spirit, of the progress of one of the most important of our industries, or rather of the very numerous industries which depend upon chemical science—(Applause). That really seems to be the justification for this impersonal form of the name of the Society. As our President has already said, there cannot be the smallest fear of entrenching upon the ground already occupied by the older Chemical Society, for there can be no doubt that chemical science benefits by the progress of chemical industry quite as much as chemical industry depends upon chemical science—(Applause). I will not detain you further, but will simply return you the very hearty thanks of myself and other visitors this evening for the toast which has been drunk.

Mr. J. C. Stevenson, M.P.—Mr. Carey Foster, in the remarks which he made a little while ago, passed a little criticism upon the name of the Association, and he observed on what he called its impersonal character in being called a Society of Chemical Industry rather than a Society of Industrial Chemists; and he ventured very properly, I think, to draw from the circumstance of the name, the consideration that you are not here engaged in a mere attempt to carry out your individual self-interest, but that you have a higher view—the promotion of industrial science in its largest aspect—(Hear, hear). That was the abstract view which he took of the name and object of your Association. But we cannot always ascend to the region of the abstract. We must come down sometimes, if not nearly altogether, to the lower ground of the concrete. It is no use to talk about the chemical industry in the abstract without remembering that there must be persons to carry on that industry, and that we cannot have an Association of Industrial Chemists and an Association of Chemical Industry without having persons to guide it, and a president to preside over its deliberations —(Applause). I am very glad that it has fallen to my lot to have the honour of proposing the toast of the first president of this first social gathering in connection with this new Association. It is our business as industrial chemists, or as what I may call very properly by the more sober name of chemical manufacturers, to apply on a large scale, and for purposes of industry, and, I should hope, sometimes, though not always, of profit—(laughter) —the principles of chemical science, which are discovered for us in the laboratory, and revealed to us by those who make science more especially their study. Everyone must know the vast difference between facts discovered and manipulated in the laboratory and those facts turned to practical account in the work of a manufactory, and I think that no one is better able to appreciate than the members of this Association how many a process which looks fair and promising in the hands of the scientific chemist utterly breaks down as a means of industry on a large scale when brought to the test of being worked, not by the grain, but by the ton. In that case we have to face the consideration of how far you can carry scientific processes into practical effect with due regard to economy, and due regard to wear and tear, and due regard to the materials of construction out of which you are obliged to make your apparatus on a large scale. These difficulties do not present themselves at all to the man who is working in the laboratory with glass vessels, and indiarubber and glass tubes. It is here that the whole difficulty of this Society of Chemical Industry exists, and I have no doubt whatever that it will be found, in the deliberations of the Society, that the most interesting questions will be how far you may be able to carry out in a practical and useful, and, I hope, profitable form, those discoveries and improvements which are suggested to you by those who take a purely scientific view of the question. Among the ranks of the scientific chemists, I know no man who would be better able to appreciate a difficulty which I have ventured to suggest than your President, Prof. Roscoe. In him a true appreciation of the facts of science is combined with an equally true appreciation of the practical difficulties of carrying those facts into practical operation. My acquaintance with your President commenced in a way which enables me to speak most heartily as to his appreciation of the difficulties of the manufacturing industry, for it was my pleasure to be associated with him on a Royal Commission with regard to noxious gases. That Commission had some very pleasant meetings, prolonged over a series of several months, and we visited many scenes of chemical industry, and among the most

interesting and pleasing reminiscences of my membership of that Commission, I regard the fact of my having made the acquaintance of your President, Prof. Roscoe, on that occasion. You have got a man who most thoroughly appreciates, as I know he can, the difficulties which attend the practice of industrial chemistry; and I may say that he and I sometimes stood alone in resisting proposals made by the rest of the commission, who did not so thoroughly appreciate the difficulties which might be found in practically carrying out things which were very desirable indeed in themselves, but which would have been a very great burden to be imposed by the law upon the chemical manufacturers of this country.—(Applause). With regard to legislative interference, I do not complain of it so long as it is wisely and judiciously directed; but we are "in for it," and we must deal with it, and the services and the advice and the testimony of a man of the experience of your President ought to be of very great value to those who are engaged in industrial pursuits, in helping them to hold their own in resisting projects of law which may be very desirable and reasonable in themselves, but which we, as practical men, know would be very disastrous and disappointing if an attempt was made to carry them out. For these reasons, though no reasons whatever were required, I ask you to join with me in drinking the health of our President. He has done his work well already to-night, and I am sure that you will agree with me that we should drink his health in the most cordial manner, with wishes for his long life and prosperity, and a desire that he may for a long time preside over the deliberations of this society.

The toast was drunk with much cheering.

Prof. ROSCOE, in replying, said—Mr. Stephenson and gentlemen, I can scarcely find words to thank you for the terms in which you have proposed, and for the cordial manner in which you have drunk, my health. I can only say that it affords me the very greatest pleasure to be of any service, in however small a matter, in promoting the chemical industries of this country. This society, as I have said before, has been founded at the right time, and I think that there is very little doubt of its permanent success—(Hear, hear). Perhaps I may be allowed, at this the first meeting, to state in one or two words the mode in which this Society has come about. Some very good friends of mine in the North were good enough about a year ago to come to me and ask me if I would assist them in forming a chemical society in Lancashire, to be constituted on much the same principles as a society which has existed for several years, and done very good work on the Tyne—the Newcastle Chemical Society. I considered their proposition, and I called to their attention a proverb which we sometimes hear in the North, which applies more to political matters than to those which are under our consideration this evening, namely, "What Lancashire thinks to-day England will think to-morrow"—(Laughter and applause). I asked them whether they did not think that that applied to chemical industries as well as to political matters. Being Lancashire men they were, I suppose, flattered by the idea, and the consequence was that I undertook to write to a number of friends and to see a number of friends of mine in London. Amongst others I may mention the President of the Institute of Chemistry, Professor Abel, whose absence this evening we all deplore because he has taken the most active interest in the matter. There was also Prof. Williamson, who favoured us with his company this afternoon, and a number of other men of high standing both in pure and in applied science. I am glad to say that their replies were favourable. They did not think that the new society would trench on any of the older ones, and they did think that there was an opening for such a society. The result is what you have witnessed to-day, and I think that we may all congratulate ourselves on having a very auspicious opening. But, gentlemen, the work of this Society has not been the work of the President. It has been far more the work of the officers of the Society. Without the co-operation, and the hearty co-operation, of those who now form your officers, it would have been impossible to do what we have done. I allude to Mr. Cook, the Treasurer; Mr. Davis, the Secretary; and Mr. Tyrer, Mr. Carey, our Northern Secretary, and Mr. Mond, our Secretary for Foreign Affairs. It is those gentlemen whom I have named to whom you owe to a great extent the success of our meeting; and, therefore, in thanking you for myself I have very much pleasure in asking you now to drink the health of the officers of the Society, coupling with the toast the name of Mr. Davis, whom we all know and respect, and whose untiring labours I do not think that you can all appreciate, but I can assure you that I can, and that I do appreciate them—(Applause).

Mr. GEORGE E. DAVIS (Hon. Gen. Sec.), in reply, said—I thank you for coupling my name with the toast which has just been drunk, but I do feel that you are praising me somewhat too highly. I have only done my duty in connection with the organisation of affairs, and I think that equal praise is due to the three other Secretaries—Mr. Mond, Mr. Carey, and Mr. Tyrer. When I attended the first meeting which was held in connection with the formation of a Society of this kind, I little thought that within three months from that time I should see an assemblage of gentlemen connected with chemistry such as I see before me this evening. Perhaps some of you may not know that the first meeting was held at Widnes on a night on which there were 6 or 7 inches of snow on the ground, and the second meeting was held in somewhat similar weather. The next meeting was held at Owens College, and there we obtained the assistance of Professor Roscoe, and from that time the Society began to grow; and I am firmly of opinion that it is chiefly owing to Professor Roscoe's hard work in the matter that this Society has attained its present position in such a short space of time. Perhaps there are very few people who think that there is much work connected with the formation of a Society of this kind; but I can assure you I do not know how Dr. Roscoe has been able to give the time and attention to it which he has done. He has placed himself entirely at my disposal, and I have sat with him for hours arranging how matters should be conducted. I think that he ought to have the larger share of any thanks which are given to me. I have great pleasure in coupling with this acknowledgment the names of the other three Secretaries, and of Mr. Rider Cook, the Treasurer.

Mr. GOSSAGE.—As a representative of the soap manufacture of this country I should like to say one or two words, because our President referred to what might be considered a slur upon the soap manufacturers. They have been throwing away a large amount of glycerin, which chemists and others have looked upon as an absolute loss to the world. But we who are soap manufacturers have not seen our way to gathering it with profit to ourselves, and that which is not gathered profitably cannot be of much use to the world in general—(Hear, hear). It was pointed out to the foreman of William Gossage and Sons by one of the members of the Rivers' Pollution Commission that we were throwing into the River Mersey a large quantity of glycerin, which a young man who referred to the loss of glycerin had put at 4s. a pound. At the time that this glycerin was being thrown into the river, the real market value was about 2d. a pound, and the other calculation was utterly fallacious. At that time the candle manufacture of this country and of the Continent supplied to the world a larger quantity of glycerin than it could consume, and consequently the tedious process of collecting glycerin from the spent lees could not be carried out profitably. Since then it has become a positive fact that the sources of glycerin are being reduced. Paraffin scale is taking the place of decomposed fats for candle making, and petroleum is taking the place of candles to the exclusion of the production of glycerin. That we have not been idle, and that we have more or less worked on the lines of the production of glycerin, is a fact which has come to my know-

ledge, more particularly within the last month. That we have to a greater or less extent arrived at the same point is also a fact. We are working at the process, and I believe that we shall succeed in recovering the glycerin from the spent lees, and thus remove the slur which has been cast upon us as chemical manufacturers. In many instances the members of manufacturing firms are too few in number to be able to carry out on a manufacturing scale all the ideas which occur to them from time to time as means of utilising what may be called by-products. If this Society had existed ten or twenty years ago, and we could have applied to it for men to carry out those rough ideas which we arrive at, I think, gentlemen, that the progress of this country would have been much greater—(Applause). I also think that a variety of waste-products would have been worked up more successfully than they have been during the last ten or fifteen years. I think that it is apparent that we, as soap-makers, are working our best to support the Society of Chemical Industry. You can almost count the soap makers of the United Kingdom upon your fingers, and we are represented by five members here. Hence it appears that the soap manufacture is not behind other manufactures of the kingdom—(Applause).

The PRESIDENT then proposed "The Press." He would not trouble them at that late hour by saying much upon this subject. The press was an agency whose importance was patent to all, and it was especially important to them as a new Society. He would couple with the toast the name of Mr. Mitchell, the representative of the *Times*.

Mr. MITCHELL, in replying, thanked the President for coupling his name with the toast. It had afforded him much pleasure to be present on that occasion. He had for many years written upon the subject of bringing the work of scientific men to bear upon the ordinary operations of life—not only in our manufacturing industries, but also in domestic affairs. With regard to the press generally, it was a very compound body. It included the work of the brain of the leader writer, the somewhat laborious work of the shorthand writer, the trouble of the compositor, the worry of the proof-reader, and the running about of little boys, commonly called "printer's devils." It also included the worry of those who had to stand the racket of the huge machines, and of the persons who had to rush off to the railway stations and catch the newspaper express. He took it that the toast was intended to comprise the work of all these persons, and he wished to acknowledge it in the same spirit.

PHYSICAL SOCIETY.

Saturday, June 25th, 1881.

Professor FULLER in the Chair.

SENOR Olympio de Barcelos was elected a member.

Mr. GRANT exhibited an apparatus for showing the position and direction of the curve of zero-electro-dynamic induction. It consisted of two coils of insulated wire mounted on stands; one being fixed, while the other was free to revolve round it at a fixed distance.

Prof. W. E. AYRTON explained the determination of the refractive index of ebonite made by himself and Professor Perry. The result for oxyhydrogen light was 1·7; but at the suggestion of Prof. Fitzgerald, of Dublin, this was checked by measuring the polarising angle of ebonite by reflected light. Lime-light was employed in these experiments and different pieces of ebonite. The result was 1·611. Professors Ayrton and Perry had repeated their former experiments, using the electric light, and a battery of 70 volts. E.M.F. The result confirmed the one first obtained. They had also determined the index of refraction in the ordinary way from the red rays which they observed to pass through the prism of ebonite. Result for the least refrangible rays 1·66.

Mr. BOYS remarked that one could see better through thin ebonite, if it was varnished or wetted, than when untreated.

A letter was read by the CHAIRMAN from a Sub-Committee of the British Association, inviting the members of the Society to send exhibits to the jubilee meeting of the British Association, at York.

Dr. JAMES MOSER read a paper "*On the Microphonic Action of Selenium Cells*," in which he argued that the action of the selenium cell, in the photophone, was that of a microphonic contact, or bad joint between the metal electrodes, or metal plates of the cell and the selenium. The heat rays of the photophonic beam caused the joint to expand and contract; hence, the variation in the current passing through the receiving telephone. Dr. Moser also exhibited a piece of selenium, which increased, not diminished, in electric resistance when light fell upon it. He further shewed a standard Daniell cell of the gravity type, which consisted of a glass vessel containing the copper plate at the bottom immersed in sulphate of copper solution and the zinc plate at the top, immersed in sulphate of zinc solution, and a clear line of demarcation between these solutions was produced by suspending an independent piece of zinc midway between the plates, so as to decompose all the sulphate of copper which diffused upwards to that point.

Prof. MCLEOD said that he had produced the same result by surrounding the zinc plate with a cage of copper wire, connected to the copper plate. Copper deposited on the cage, and the cell was in constant use.

Dr. LODGE said that arrangement would not, however, serve as a standard of electro-motive force, because all the copper plate should be in the copper solution. In his cell, the copper and solution are both in a test-tube immersed in the zinc solution, and diffusion has to take place up this test-tube and down the cell, so as to enter a second tube, open at the bottom in which the zinc is placed.

Dr. GUTHRIE shewed a new experiment to the effect that when a magnet is suspended over a disc of copper, and the disc rotated, the magnet is repelled upwards. The experiment was shewn by suspending the horse-shoe magnet from one end of a scale beam counter-weighted. As a possible explanation, he suggested that the vertically resolved force of the induction current before the magnet might be greater than that behind the magnet.

The SECRETARY read a paper by Prof. BALFOUR STEWART and Mr. W. STRODE "*On Results Obtained by a Modification of Bunsen's Calorimeter*," described to the Society in January last year. With a new instrument made by Casella, they have determined the mean specific heat of iron to be 0·1118, and that of sulphur 0·1756; the true values being given as 0·1138 and 0·1776. The advantage of the method is its simplicity, and the fact that very small quantities of the substance may be used.

Dr. LODGE then explained experiments by Mr. SUTHERLAND showing that a Daniell cell keeps its E.M.F. very constant when heated, because the thermo-electric effect at the junction of the zinc with the solution is balanced by that at the junction of the copper with the solution.

After remarks by Dr. MOSER and Prof. PERRY, the Society separated until November next.

CORRESPONDENCE.

CURIOUS ACTINIC PHENOMENON.

To the Editor of the Chemical News.

SIR,—The "Curious Actinic Phenomenon" referred to in the CHEMICAL NEWS, vol. xliii., p. 283, is not by any means a new thing. It was not only noticed, but was a difficulty, when I began to manufacture the pigment nearly ten years ago. For several years thereafter, however, I supplied Mr. Thos. Griffiths, F.C.S., with the article which

was not subject to this actinic influence. Much explanation would seem to be required in order to understand Dr. Phipson's remarks on this subject.

A gate post painted with white, on which there was a leaden hue in the sunlight, would *naturally* appear whiter at night, and would not be black under any circumstances, unless in the total absence of light.

If the pigment were "prepared by precipitating a solution of sulphate of zinc by another of sulphide of barium" and calcined, as it seems to have been, whence comes the protoxide of iron, and in such quantity, and how can sulphide of barium of arsenic be present?

Pigment containing the ingredients named by Dr. Phipson would not be white, and could scarcely contain 16 per cent of oxide of zinc unless by mechanical addition.

In fact, the pigment, properly made, does not contain a trace of either iron, lead, arsenic, or manganese, and yet insolation produces this bluish colouration unless means be taken to prevent it.

Of course, the Doctor's statements spring from a laudable desire to keep us informed, and one must not be captious; but his theory on this subject is improbable.— I am, &c.,

JOHN B. ORR.

107, Cannon Street, E.C.,
June 29, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 21, May 23, 1881.

Barometer Based upon the Equivalence of Heat and Pressure upon the Volume of a Gas.—C. Decharme.—To find the atmospheric pressure it is sufficient to take the temperature with a common thermometer, and the volume of the gas in an air thermometer.

Production of Sound by the Force of Radiation.—A. Graham Bell.—A translation of a memoir read before the National Academy of Arts and Sciences, April 21, 1881.

Radiophony: a Thermophone Reproducing the Voice.—E. Mercadier.—With the simple apparatus which the author calls a thermophone, he has been able to reproduce a continuous scale of musical sounds, from the deepest to those corresponding to more than 2000 complete vibrations per second, and in an equally continuous manner the succession of perfect chords of which the fundamental sound runs through this long scale.

Modification of Neef's Interruptor for Ruhmkorff's Coil.—The vibrating spring is fixed, being elongated, and its two extremities are fixed by means of two columns. In the middle of the length of this plate is a small mass of soft iron, which is attracted by the bundle of iron wires of the coil. The screw which fixes the mass of soft iron is platinised, and opposite it is the tapering rod, which serves to produce the interruptions of the current in the induced circuit of the coil. An antagonistic spring, capable of being variously regulated, gives the suitable tension. Neef's interruptor thus arranged gives a considerable number of vibrations in a very short time.

The Rotatory Power of Artificial Codeine.—E. Grimaux.—The author's result is $(\alpha)_D = -130{\cdot}34°$. Under the same conditions natural codeine shows $(\alpha)_D = -133{\cdot}18$.

Proportion of Carbonic Acid Contained in the Air.—A. Muntz and E. Aubin.—The authors have found in 10,000 parts of air in the outskirts of Paris 2·73, 2·90, and 2·99 of carbonic acid. The mean for the day is 2·85, and for the night 3·00. The values thus found differ little from the figures obtained by M. Reiset on the sea-shore, near Dieppe.

Preliminary Thermo-chemical Study of Reactions without the Intervention of a Solvent.—M. Lorin.—A continuation of the author's studies on the action of the acids upon salts without the intervention of a solvent. It appears that formic acid displaces, more or less, all the acids. Its combining power is intermediate between that of the organic acids and that of the most powerful inorganic acids. Thermic reactions assign thallium a place among the alkaline metals.

Silico-molybdates.—F. Parmentier.—Silicic acid gives under certain circumstances yellow precipitates with the alkaline molybdates, which are more soluble in acids than the corresponding phospho- and arsenio-molybdates. Their general formula is $2R,SiO_2,13MoO_3+nAq$.

Action of Ammonia upon Isobutylen Chloride.—S. Œconomides.—Besides the isobutylen chloride the author has obtained the hydrochlorates of certain mixed bases.

Journal für Praktische Chemie.
Parts 19 and 20, 1880.

On Lead Glycerides and the Quantitative Determination of Glycerin.—T. Morawski.—The author traces the hardening of "glycerin putty," a mixture of lead oxide and glycerin, to the separation of water. In addition to the mono-plumbo-glycerin formerly known, he has obtained a sesqui- and a penta- compound, and a plumbo-nitrato-glyceride. The method for the determination of glycerin is not yet fully elaborated.

Phospho-tungstic Acid.—Max Sprenger.—For this acid the author gives the formula $P_2O_5,24WO_3+61H_2O$. He has examined its salts, and on decomposing the barium salt with sulphuric acid he obtains another acid,—

$$P_2O_5,22WO_3+x\ aq.$$

Researches on the Volume-Constitution of the Sulphates, Chromates, and Seleniates.—H. Schroeder.—Among the principal conclusions reached in this memoir are the following:—Manganese in its sulphates and seleniates is isostere with cobalt, iron, zinc, magnesium, and copper. In its hydrates the water in the manganese compound occupies a stere more space than in the corresponding compounds of the other radicles. The water in the hydrated nickel salts is generally more condensed by a half or a whole stere than in the corresponding salts of magnesium, zinc, iron, cobalt, and copper. The stere of the seleniates is slightly greater than that of the corresponding sulphates. The stere of an ammonium compound is slightly greater than that of the corresponding potassium compound.

Para-oxy-phenol and Certain Aldehyds and Alcohols Derived from Hydroquinon.—Dr. A. Hantzsch.—An account of para-diazo-phenetol-chloride, the corresponding sulphate para-oxy-phenetol, ethyl-para-oxy-salicyl-aldehyd, the corresponding aceto-ethyl- and diethyl-compounds; the behaviour of the aldehyds with oxidising agents, mono-nitro-diethyl-para-oxy-salicyl-aldehyd, the behaviour of the aldehyds with reducing agents, and of ethyl-para-oxy-saligenine.

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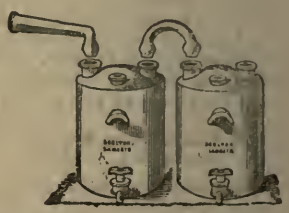

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1128.

ON STRATIFED DISCHARGES.*

VI.—Shadows of Striæ.

By WILLIAM SPOTTISWOODE, President R.S., and J. FLETCHER MOULTON, F.R.S.

One of the most interesting questions connected with the subject of stratified discharges is this: What is the physical, as distinguished from the electrical, nature of the striæ themselves? Are they, in fact, to be regarded as aggregations of matter possessing greater density than the gas present in the dark spaces, or are they to be considered as indicating merely special local electrical conditions? The fact of their having a definite configuration, especially on the side which is turned towards the negative terminal of the tube, that of their temperature being higher than that of the dark spaces, the manner in which they are affected by solid bodies, and other considerations, all tend to give support to the view that the striæ are loci of greater density than the dark spaces. Still it can hardly be said that as yet any experimental proof of this has been given sufficiently decisive to decide the question conclusively. And it is in the hope of contributing something towards the solution of this question that the following experiments are submitted to the notice of the Royal Society.

In the former papers of this series (*Proc. Roy. Soc.*, vols. 23, 27), and in our memoirs "On the Sensitive State of Vacuum Discharges" (*Phil. Trans.*, 1879, p. 155, and 1880, p. 561), we have described experiments which show how a discharge through a tube, whether sensitive or non-sensitive, may be affected in various ways by intermittent discharges *ab extra*. In the experiments now to be described the problem has been reversed, and it has been proposed to ascertain how far such an external discharge can itself be affected by the internal one. The discharge *ab extra*, however, presents such feeble luminosity, that it is not possible to come to any certain conclusions on this head by direct methods. But, as has been before pointed out, the intermittent discharge *ab extra* is eminently calculated to produce Crookes's green phosphorescence, and the effect produced on this phosphorescence by the striæ of the internal discharge proves to be not only well marked, but even striking, and of this we now propose to give an account.

In the second of the two memoirs above quoted, Section 14, we studied "the effect of intermittent inductive action of an impulsive type upon continous discharges." In the present instance the instrumental disposition was not very different from that which was there described. The two terminals of a Holtz machine were connected in the usual way with the two terminals of the tube, so as to produce a stratified discharge. A narrow strip of tin-foil, or a wire, was stretched along the tube opposite the column of striæ, but not extending much beyond it. The reason for the latter precaution will be mentioned below. The positive terminal of a second Holtz machine (in practice we used for this purpose a Töppler machine) was connected with the tin-foil, and the negative terminal with one (either) terminal of the tube. An air-spark, or interval across which sparks could pass, was interposed in the part of the circuit between the machine and the tin-foil. The effect of this arrangement was similar to that described in our first memoir, p. 170, viz., in the interval between two sparks the tin-foil and tube became charged like a Leyden jar; the tin-foil being the outer coating, charged positively, and the gas inside serving as the inner coating, charged negatively. When the spark passed across the interval mentioned above, the jar (*i.e.*, the tube) became discharged, and the electricity previously held bound on the two coatings was set free.

When the first (say the "internal") machine was not working, or when it was disconnected—*i.e.*, when no regular discharge was passing through the tube—then, whenever a spark passed at the second (or "external") machine, a negative discharge with its accompanying Crookes's radiation took place from the inside of the tube next the tin-foil, and the opposite side of the tube became covered with a sheet of green phosphorescence (the tube being of German glass). The length of the sheet was equal to, or very slightly greater than, that of the tin-foil strip, while the breadth was measured by the angular dispersion from the strip, as described in the second memoir.

When, however, other things remaining as before, a discharge from the internal machine was sent through the tube, and a good stratified column was produced, it was found that the green phosphorescence was entirely cut off from the parts of the tube opposite to the striæ, while on the parts opposite to the dark spaces it remained, in the form of phosphorescent rings, as brilliant as before. The experiment was repeated with various tubes with various degrees of strength of current, and with various densities of gas (produced by heating a chamber of potash in connection with the tube). It may be added that when, as is sometimes the case, through greater exhaustion, the striæ became feebler in illumination and less compact in appearance, the shadows cast by them lost proportionally in sharpness of definition and in completeness of extinction of the phosphorescent light.

The reason for not extending the tin-foil beyond the column of striæ is, that when this is done the negative discharge from inside the strip combines with that going on in the main dark space behind the ancnored striæ in such a manner as to shorten the column by the length of the strip. When this takes place, as is often, although not always, the case, the experiment is frustrated.

The brilliancy and definition of the phosphorescent rings may be increased by inserting a small Leyden jar in the circuit, care being taken that the jar shall discharge itself completely each time. If this is not the case, the main discharge is followed by subsidiary discharges, which tend to blur the effect. The angle of dispersion may be increased, or rather supplemented, by placing more than one strip on the tube, distant from one another by an angle of 90° or 120°. By this means the rings may be made to comprise the entire circumference of the tube.

It should be here mentioned that if the striated column be carefully examined at the moment when the external discharge passes, it will be noticed that the entire column (or more strictly speaking, the part of it lying between the positive column and the end of the tin-foil nearest to the positive terminal) undergoes a slight displacement. This displacement amounts usually to half the distance between two striæ. The actual shadows cast in the green phosphorescence are those due to the displaced striæ, as may be easily verified.

It thus appears that the striæ are competent to cast shadows in the radiant showers issuing from the inside of the tube adjacent to the tin-foil, which part acts as a negative terminal. Many experiments have contributed to show that these radiant showers, although accompaniments of the discharge, are not carriers; and that, having once issued from their source, they continue their own course irrespective of that of the discharge proper. They are, in fact, material showers, and, although not improbably charged with electricity, yet their ulterior course does not appear to depend on their electrical condition. Under these circumstances they can be arrested only by a material obstacle, and consequently the phenomena above described may be considered as furnishing an experimental proof that the striæ represent local aggregations of matter, and not merely special electrical conditions of the gas.

* A Paper read before the Royal Society, June 16, 1881.

ON THE INFLUENCE OF COAL-DUST IN COLLIERY EXPLOSIONS.*

No. III.

By W. GALLOWAY.

THE information that can be gleaned from a study of the three great colliery explosions of the past year—namely, Risca, Seaham, and Penygraig—appears to throw more light upon the question than anything that has been elicited experimentally either by myself or others since I last had the honour of addressing the Fellows on the same subject. These explosions took place on the 15th of July, the 8th of September, and the 10th of December respectively, and they cost the lives of no fewer than 385 persons in all—Risca, 120; Seaham, 164; and Penygraig, 101.

For the purposes of the present paper I visited Risca Colliery on the 24th of October, and Seaham Colliery on the 24th of November, and I have had the rare opportunity of becoming thoroughly conversant with every circumstance connected with the Penygraig explosion, and with the events which immediately preceded and accompanied its occurrence.

A careful consideration of all the preceding details has irresistibly convinced me that, whatever may be the results of experiments with coal-dust made on a small scale, this is not a mere question of "adding fuel to the flame," of "aggravating the consequence of an explosion," of "spreading an explosion," or of "lengthening out the flame of fire-damp," or that of a blown-out shot. Expressions of that kind not only fail to convey a true idea of the actual state of matters, but they are apt to be misleading. I might describe the impression upon my own mind to be somewhat as follows.—Given a well-ventilated or badly-ventilated dry mine with moderately clean fine dry coal-dust lying everywhere all over the workings, and of any quality varying from a long-flaming house-coal, like that of Blantyre, on the one hand, to a semi-bituminous steam coal, like that of Penygraig, on the other hand, then if an explosion be begun at any point in one of the only three possible ways—(1) By the coal-dust being raised and ignited by a blown-out or other shot; (2) by an explosive accumulation of firedamp and air being ignited by a blown-out or other shot; (3) by an explosive accumulation being ignited accidentally by a defective or other safety-lamp, or in any other manner—and if it accumulates a certain degree of fuel without dying out, that force will go on increasing, and the explosion will inevitably extend to every open space in the workings, whatever may be their extent or ramifications. I make no mention of firedamp as necessary to the attainment of this result, with the exception of the comparatively small quantity required to create the first disturbance. It must not be imagined, however, that I lose sight of the *latent* firedamp contained in the air of every mine of this class. On the contrary, I am satisfied that that firedamp plays a most important part in every great explosion, and I have endeavoured strongly to urge this view in both of my previous papers.

International Medical and Sanitary Exhibition.—An Exhibition of Medical and Sanitary Appliances, &c., promoted by the Parkes Museum of Hygiene, will be held at South Kensington from July 16th to August 31st, 1881. The opening ceremony will take place at the Royal Albert Hall, on Saturday, July 16th. The chair will be taken at 4.30 p.m. by the Right Hon. Earl Spencer, K.G., supported by the Right Hon. Earl Granville, K.G., the Right Hon. J. G. Dodson, M.P., Sir James Paget, Bart., F.R.S., and J. Eric Erichsen, F.R.S.

* Abstract of a Paper read before the Royal Society, June 16, 1881

COLLIERY EXPLOSIONS.*

By F. A. ABEL, C.B., F.R.S., President of the Institute of Chemistry, Chemist to the War Department, &c.

ON November 19th, 1880, I received a communication from Mr. Thomas Bell, Her Majesty's Inspector of Mines, Durham District, informing me that a series of samples of dust from Seaham Colliery, collected subsequent to the explosion of September 8th, 1880, by himself and assistants, and by the Miners' Executive at Durham, had been forwarded to me to Woolwich, and that in accordance with my request larger quantities of the same samples had been sent, for purposes of special experiment by me, to Garswood Hall Colliery near Wigan, with the exception of three, which it was thought might have been burnt by the explosion, and of which only small quantities had been collected.

The descriptive list of the samples accompanying Mr. Bell's letter is appended.

A memorandum containing a few additional particulars with regard to these samples was afterwards received by me from Mr. Bell, and also a skeleton plan of the colliery; upon which were indicated by letters, corresponding to the markings of the samples, the places where they were collected.

The samples, 13 in number, which were sent to Woolwich, were in the first instance dried at a temperature of 100° Farhenheit, and passed through a sieve of 50 meshes to the inch, so as to remove the coarser particles, which in some instances existed in very large proportion in the specimens.

I.

The accompanying is a tabulated statement of the results furnished by chemical, mechanical, and microscopic examination of the finer, or sifted, portions of the whole of these samples.

It will be seen from an examination of the table that there were considerable differences in the amount of actual *coal*-dust contained in the different samples. The sample marked X, collected from the screens, was found to consist almost entirely of coal; taking it, therefore, as representing approximately in composition the coal-dust itself furnished by this colliery, an estimate which, though rough, is sufficiently near for purposes of practical comparison, was based upon it (as shown in the table) of the proportion of coal-dust existing in the several other samples of sifted dust.

This comparison shows that the actual coal-dust in the other samples ranged from about 96 to 54 parts in 100 of the sifted dust, dried at 100° Fahrenheit.

The samples K, L, collected at the curve in the Stone Drift near No. 1 and 2 pits, consisted chiefly of coal-dust, while those taken from off props and stones on the off side of No. 1 Engine Plane (S) from beyond the end of the Stone Drift No. 1 pit, 3rd East way (V), and from near the Maudlin Engine (M), also contained very large proportions of coal. The sample from No. 3, Hutton Seam, South way (N) consisted, on the other hand, of little more than half its weight of coal. This sample presents special interest, as will be seen further on, in reference to the question of the influence of dust in promoting or aggravating explosions in coal-mines.

The microscopical examination of portions of the samples, as received, was specially directed to the detection in them of coal particles which had been affected by heat. No such particles were discovered in samples K and L (taken from the curve in the Stone Drift), in M (collected near Maudlin Engine), in V (collected beyond the end of the Stone Drift, in No. 3 East way), nor in sample X, taken from the screens. A few particles of

* Report on the Results of Experiments made, with Samples of Dust collected at Seaham Colliery, in compliance with the request of the Secretary of State for the Home Department, conveyed by letter dated November 4th, 1880.

TABLE I.

PARTICULARS REGARDING SAMPLES OF COAL-DUST COLLECTED IN SEAHAM COLLIERY, 15TH AND 16TH NOV., 1880.

Sample.	Where taken.	Coke including Ash.	Ash.	Volatile Matter (including Water).	Mechanical Water given off at 300° F.	Volatile Matter minus Mechanical Water.	Percentage (approximate) of Coal-dust in sample. Coal-dust containing 10 per cent Ash and 1 per cent Moisture.	Colour of Samples. Order from Black to Grey.	Percentage of Dust passing through sieve of 80 meshes to the inch. After having passed through sieve of 50 meshes to the inch.
†K	From floor of curve in stone drift	78·39	14·96	21·61	2·65	18·96	93·39	2	98·8
L*	From curve in stone drift, scraped off baulks of timber near the roof on which it was deposited, in some places, more than an inch thick.	79·24	12·00	20·76	3·07	17·69	95·93	2	100
†M	From near Maudlin Engine, supposed to have been affected by explosion.	79·55	25·31	20·45	5·28	15·17	80·41	2	84·3
†N	From No. 3, Hutton seam, south way.	85·50	55·41	14·50	1·81	12·69	53·78	8 light grey	81·4
†O	From old incline floor.	82·21	37·43	17·79	3·63	14·16	69·94	4	85·7
P*	From old incline floor, mostly scraped off timbers blown out by the explosion, the rest off flat stones.	86·86	42·50	13·14	3·67	9·47	64·83	3	92·5
Q*	Scraped off flat stones, &c., on return side of Polka doors.	89·15	34·22	10·85	3·67	7·18	73·11	5	100
†R	Off side of No. 1 engine plane at long turn.	81·27	37·36	18·73	4·21	14·52	69·43	7 greyish brown	74·3
†S	Do. do. do. do. off props and stones.	80·16	24·13	19·84	2·64	17·20	84·23	3	94·7
†T	From floor in No. 1 travelling road.	79·40	36·44	20·60	4·10	16·50	70·46	7 greyish brown	77·9
†U	From floor in stone drift, No. 1 pit, third east way.	80·60	40·92	19·40	2·91	16·49	67·17	6	80·9
†V	From ground, three pillars beyond end of stone drift, in third east way, No. 1 pit.	76·55	24·87	23·45	3·21	20·24	82·92	5	85·6
†X	From 1 and 2 screens, probably accumulated slowly and over a long period.	79·72	10·25	20·28	1·00	19·28	99·75	1 black	100

Microscopic Examination.

K.—Coal particles glistening and sharp, various sizes, very few mineral particles.

L.—Particles uniform in size, but much finer than K, all glistening and sharp, very few mineral particles.

M.—Large sharp coal particles mixed with fragments of minerals.

N.—A *very* few large particles of coal-dust and a small proportion of very fine particles, some of which appeared to have been affected by heat. Consists largely of fine sand and other mineral particles.

O.—Some coarse mineral particles and coarse coal particles mostly covered with greyish dust; the larger proportion consists of fine glistening particles; some of the coarser particles appeared to be coked.

P.—Fine, and much more uniform in size than O; some coarse mineral particles. Some coal particles had been affected by heat.

Q.—Particles much collected together, less glistening than other samples, fine dust apparently clinging to them. Many of the particles had been acted upon by heat.

R.—Very large proportion of coarse mineral particles, a few coal-dust particles, and much coke.

S.—A few rather coarse mineral particles, a comparatively large proportion of uniformly fine coal-dust, of which some had been affected by heat.

T.—All clean coarse particles of coal, coke, and minerals; no very fine dust.

U.—Coarse particles of coal and minerals, with fine sand, and coke-dust particles adhering. Great variations in size.

V.—Clean coarse particles, chiefly coal. A small proportion of fine; some particles of wood and straw.

X.—Coal-dust particles, fine and very uniform. No mineral particles observed.

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sample H, from South way, No. 3, Hutton Seam, appeared to afford evidence, though not of a very decided nature, of having been acted upon by heat; the same was the case with sample O, from the floor of the Old Incline. A few particles in sample P, from the same locality (scraped off timbers and flat stones), furnished more decided evidence of exposure to a high temperature. The remaining five samples all contained coked particles of dust, the proportions being comparatively small in samples (U) from floor in No. 1 Stone Drift, 3rd East way) and S (from props and stones at off side of No. 1, Engine Plane), while they were considerable in sample R, from the same locality, in Q (collected off flat stones on return side of Polka doors), and in T (from floor in No. 1 Travelling Road).

The memorandum from Mr. R. S. Wright, which was transmitted to me in the Under Secretary of State's letter of November 4th, 1880 (and is appended to this report), specified the points which it was desired to have elucidated by the examination of dust samples; it states that samples of burnt dust should be analysed with a view to an opinion whether such burnt dust is—

(1.) The ash or product of dust burnt by an explosion of fire-damp; or is

(2.) The remains or product of dust which has itself been explosively burned (with or without fire-damp) whilst suspended in air.

The meaning which is intended to be attached to the term "explosively burnt" is not very obvious, but it may

be at once stated, with reference to this part of the memorandum, that—

(1.) Although some coal-dust particles in several of the samples exhibited signs, as described, of having been exposed to a high temperature, the samples Q and R are the only two which might be described as *burnt* dust; even these contained respectively 7 and 14·5 per cent of volatile matters (exclusive of 3·67 and 4·2 per cent of water, not driven off at 100° Fahrenheit), and consequently consisted in part of unburnt dust.

(2.) It therefore appears evident, either that the upper or superficial portions of these samples, in the positions in which the dust accumulations were found by the collectors of them, had been attacked by the heat of the explosion, the portions beneath the surface remaining unaffected, or that portions of the dust suspended in the air at the time of the explosion, and partially burnt while taking part in its development and propagation, or consequent upon their exposure to the heat of the explosion, had been deposited after the explosion upon the top of accumulations of unburnt dust. In either case the burnt dust must obviously have become mixed in the process of collection with a more or less preponderating proportion of unburnt dust, upon which it had, in some instances, been deposited or produced only to the extent of a thin film.

(3) The chemical and microscopical examination of the dust samples collected in the Seaham Colliery in November last did not consequently furnish any data to lead to conclusions as to the *extent* to which the dust may have taken part in the production or augmentation and transmission of the explosion.

(4.) On the other hand, the examination has served to show—

(*a*) That the dust samples collected in different parts of the colliery differed very considerably in the proportion of coal-dust and of other matters which they contained, as well as in their mechanical condition;

(*b*) That, after the explosion, coked or partially burnt dust existed, though apparently not in very considerable proportion, at several points very distant from each other and in different directions, as in the samples U from near extremity of stone drift, No. 1 pit, P from old incline floor, R from south way, Hutton seam, and S from No. 1, travelling road;

(*c*) That the dust samples K, L, and M, collected from the curve in Stone Drift, and from near Maudlin engine—*i.e.*, at those points selected for the purposes of this enquiry which are nearest to the spot where the shot was fired at the time that the explosion occurred—afforded no evidence of having been subjected to the action of a high temperature.

With regard to points 1 and 2A in Mr. Wright's memorandum, neither chemical nor microscopical examination could furnish any indication of a characteristic difference between "the ash or product of dust burnt by an explosion of fire-damp, and that which has itself been (explosively?) burnt with or without fire-damp, whilst suspended in the air." If, in the latter case, the quantity of dust suspended in the air (in addition to, or without, fire-damp) be such that the proportion borne by the atmospheric oxygen is that, or in excess of that, required for the combustion of the inflammable constituents of the coal particles, the latter *might* be *completely* coked and even partly burnt *to ash*, though the completeness of the result would depend much upon the inflammability and fineness of the dust, upon the rapidity of the explosion, and upon the amount of heat developed. It is more than probable, however, that at any rate a large proportion of the coal-dust suspended in the air at the time of a fire-damp explosion, or of an explosion produced, if it be possible, by the sole agency of coal-dust, would only be partially coked, and such would also be the case with deposits of coal-dust exposed to the heat and flame of a fire-damp explosion.

In the latter case, if the coal be a caking coal, and the dust contain but little matter foreign to coal, a crust, or conglomerate, of partially coked dust may be formed, but the non-existence of any evidence of such aggregations in the samples collected in the Seaham Colliery cannot be accepted as any positive indication that this particular action of heat had not taken place in the localities where the specimens had been collected, because any coked dust of this particular form would have become again reduced to dust in the handling, transport, &c., of the samples.

The ten larger samples of dust sent to Brynn from Seaham (of which smaller portions had been received at Woolwich and examined, and which are marked † in the descriptive list) were found to be all more or less moist, and as means for their proper desiccation, without application of excessive heat, did not exist at the colliery, they were transmitted to Woolwich, where they were carefully dried in a core-drying stove in the Royal Arsenal Shell Foundry, and sifted so as to separate all coarser particles; the sifted samples were then packed to exclude access o damp, and returned to Brynn for experiment.

The samples were compared with each other, and also with samples of coal-dust obtained from various collieries at which serious explosions had recently occurred, with respect to the proportion of fire-damp to air which a suspension of each particular sample in the gas-mixture would cause to be exploded readily by contact with the naked flame of a Davy lamp.

In this way a reliable estimate appeared to be arrived at of the comparative sensitiveness, or of the comparatively dangerous character, of the different dust samples.

The results of this comparison are given in the second part of this report.

(To be continued.)

SELENIUM AND ITS APPLICATIONS TO THE PHOTOPHONE AND TELEPHOTOGRAPHY.*

By SHELFORD BIDWELL, M.A., LL.B., M.R.I.

(Concluded from p. 2.)

By the help of a reflecting galvanometer I now propose to show you the various effects produced by different parts of the spectrum of the electric light formed by a bisulphide prism upon the resistance of a selenium cell. The maximum deflection is seen to occur when the selenium is at the extreme outer edge of the red.

The effect of interposing various coloured glasses between a gas flame and the selenium cell was also tried. The greatest effect was produced by orange glass, the smallest by green. It was, too, observed as a remarkable fact that the light transmitted by a dark blue glass produced a greater effect than that which had been passed through a blue glass of much lighter tint. But on a spectroscopic examination the darker one was found to transmit a certain portion of red light. I also tried the effect of radiation from a black-hot poker held at a distance of about 6 inches from the selenium, and upon the first trial found that the resistance, instead of being diminished was increased by several thousand ohms. I imagined this to be due to a rise of temperature in the selenium, and was thus led to experiment upon the effect of temperature. In this matter, too, there is a remarkable discrepancy between the authorities. Prof. Adams says that an increase of temperature *increases* the resistance of selenium, and even suggests that a selenium bar should be used for the construction of a very delicate thermometer. Dr. Guthrie, Messrs. Draper and Moss, and others, make the directly opposite assertion that the resistance of selenium *diminishes* with heat. I repeated my poker experi-

* A Paper read before the Royal Institution of Great Britain, Friday, March 11, 1881.

ment, which had in the former case apparently corroborated Prof. Adams, and now to my utter astonishment I found that the resistance was greatly diminished. This second experiment, therefore, seemed to support Dr. Guthrie's statement. A great number of experiments were now undertaken for the purpose of arriving at the truth of the matter, with the details of which I will not weary you. Solutions of alum in water, of iodine in bisulphide of carbon, plates of glass and of ebonite were interposed between the selenium and the sources of light and heat. The selenium was now fried, now frozen; and the most contradictory results were obtained. At one moment I felt convinced that Prof. Adams was right, at the next there appeared to be no shadow of doubt that Dr. Guthrie's was the true theory. In fact, it seemed as if the selenium was possessed by a demon which produced the variations in accordance with the caprices of its own unaccountable will. At length, when the confusion was at its height and the demon most bewildering, the true explanation was suddenly revealed, and so exceedingly simple is it that now the only marvel is that it should have so long eluded discovery. The secret of the matter is this, and it discloses one of the most remarkable properties of this most remarkable substance:—There is a certain degree of temperature at which a piece of crystalline selenium has a maximum resistance. If a piece of selenium at this temperature is exposed to either heat or cold—it matters not which—its resistance will at once be diminished; and extremes of either produce a far greater variation than is ever effected by the action of light. A selenium cell which, at the ordinary temperature measured in a dim light 110,000 ohms, was reduced by immersing it in oil at 115° C. to 18,000 ohms. The resistance of the same cell was reduced by immersing it in turpentine at −6° C. to 49,000 ohms. In the case of the single cell with which I have hitherto made the experiment, the temperature on each side of which the resistance is diminished is 24° C.* Let this piece of selenium be gradually raised from a temperature of zero to a temperature of 100° C. While passing from zero to 24°, its resistance will rapidly increase. Passing from 24° to 100° its resistance will again rapidly diminish. (This experiment was successfully shown.)

Until Prof. Bell directed his attention to selenium, all observations concerning the effect of light upon its conductivity had been made by means of the galvanometer. But it occurred to him that the marvellously sensitive telephone which he has invented might with advantage be used for the purpose, and on the 17th May, 1878, he announced in this theatre "the possibility," to use his own words, "of hearing a shadow by interrupting the action of light upon selenium." A few days afterwards Mr. Willoughby Smith informed the Society of Telegraph Engineers that he had carried this idea into effect, and had heard the action of a ray of light upon a piece of crystalline selenium.

When a selenium cell, a telephone, and a battery are connected in circuit, a uniform current of electricity will, under ordinary circumstances, flow through the telephone, and a person listening would hear nothing. Suppose, now, that a series of flashes of light were allowed to fall upon the selenium. In the intervals of darkness the selenium cell would offer a greater resistance to the passage of the electric current than during the intervals of light. The strength of the current would be constantly varying; and if the flashes succeeded one another quickly enough and with sufficient regularity, a musical note would now be heard by a person listening at the telephone. The exact pitch of this note would of course depend upon the rate at which the flashes succeeded one another, being high when the succession is rapid, low when it is slow. The nature of this sound is very peculiar, reminding one of the moaning of a syren or the rising and falling of the wind. With a sufficiently sensitive cell, powerful battery, and delicate telephone, the sound may be heard at a distance of many feet.

I shall interrupt the steady beam of light which is now falling upon the cell by causing a zinc disk with radial slits cut in it to rotate in the path of the beam, and the sound produced by the rapid succession of light and shade upon the selenium cell will be heard in the telephone. When the cell is screened from the light, the sound at once ceases. When the screen is removed, the sound is again heard as before. By using a system analogous to that of dots and dashes, an intermittent beam of light might be employed to convey photophonic messages to a distance.

But Prof. Bell has gone further than this. He was not satisfied with merely *interrupting* a steady beam of light, producing alternately strong light and total darkness, but he aimed at graduating its intensity in correspondence with the varying phases of the complex sound-waves produced by the human voice. It is evident that if a beam so regulated were allowed to fall upon the selenium cell, the exact words spoken, with their articulation unimpaired, would be reproduced in the telephone. Prof. Bell adopted a device which is equally marvellous for its extraordinary simplicity and for its perfect efficiency. The beam of light is made to fall upon the face of a small flexible mirror, whence it is reflected to the distant selenium cell, lenses being used for the purpose of rendering the rays parallel and condensing them where required. The speaker directs his voice upon the back of the mirror, which takes up the sound-waves and is thrown into a state of vibration, thus becoming alternately concave and convex. Now, when it is concave the light reflected by it is more concentrated, and the selenium cell more brightly illuminated. On the other hand, when it is convex, the opposite effect is produced; the rays are more dispersed and the illumination of the cell less intense. And since the movements of the mirror are in exact correspondence with the sound-waves of the voice, so also will be the intensity of the illumination of the selenium cell. The strength of the current passing through it will vary in the same proportion, and will cause the telephone plate to vibrate in consonance with the mirror, and thus to reproduce the exact sounds by which the mirror was set in motion.

In the small experimental photophone which is before you, the receiving station is within 20 feet of the transmitter, and any sounds heard in the telephone would of course be utterly drowned by the actual voice of the speaker at the mirror. It is necessary, therefore, to prolong the telephone wires, and carry them to a distant room, where the sounds that have travelled along the beam of light can be heard without interruption. Prof. Bell, using, instead of a lens, a large reflector for receiving the beam of light, has heard words which were spoken when the mirror was 700 feet away from the selenium cell.

It is impossible to exhibit the photophone in action to an audience, because the effects can only be heard by a single person at a time. But I may mention, that in the course of some experiments with this little instrument which Prof. Tyndall very kindly permitted me to make here on the 7th of December last, every word transmitted by it was perfectly understood.

I propose now to say a few words upon another and very different application of selenium. In point of interest and importance it cannot be compared with the photophone: but since it is a child of my own I naturally regard it with a certain amount of affection. It occurred to me a few months ago that the wonderful property of selenium, which we have been discussing this evening, might be applied in the construction of an instrument for transmitting pictures of natural objects to a distance along a telegraph wire. I have constructed a rough experimental apparatus in order to ascertain whether my ideas could be carried out in practice, and it is so far successful, that although the pictures hitherto transmitted are of a very rudimentary character, I think there can be little doubt

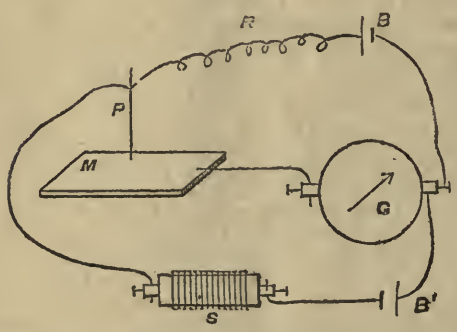
* The experiment has since been repeated with five other cells, and their temperatures of maximum resistance were found to be 23° 14°, 30°, 25°, and 22° respectively.

that further elaboration of the instrument would render it far more effective.

Iodide of potassium is very easily decomposed by a current of electricity. If a piece of paper which has been soaked in a solution of this substance be laid on a piece of metal, M, Fig. 2, which is connected to the negative pole of a battery, B, and a piece of platinum wire, P, which is connected with the positive pole, be drawn over its surface, the path of the point will be marked by a brown line, due to the liberation of iodine. Let the platinum wire and the metal plate be connected to a second battery B' in such a manner that a current of electricity may pass through the paper in the opposite direction; and let a variable resistance, R, be inserted between the platinum wire and first battery, B, and the selenium cell, S, between the platinum wire and the second battery. And let the resistance be so adjusted that when the selenium cell is exposed to a strong light, the two opposite currents through the paper and the galvanometer, G, neutralise each other; then the point when drawn over the paper will make no mark. But if the selenium cell is shaded, its resistance will be immediately increased, and the current from the first battery will predominate. The point, if moved over the paper, will now trace a strong line, which, if the selenium is again exposed, will be broken off or enfeebled according to the intensity of the light. (Exp.)

If a series of these brown lines were drawn parallel to one another and very close together, it is evident that by

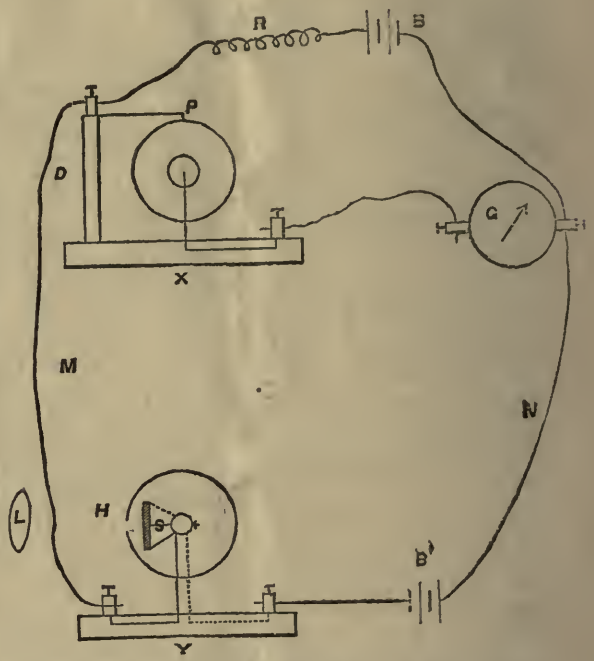
Fig. 2.



regulating their intensity and introducing gaps in the proper places any design or picture might be represented. This is the principle of Bakewell's copying telegraph, which will transmit writing or pictures drawn upon tinfoil with a non-conducting ink. My instrument differs from his in that the current is varied simply by the action of light. The transmitting instrument, Y, Fig. 3, consists of a small cylindrical box, 2 inches deep, mounted upon a horizontal spindle, upon which is cut a screw having sixty-four threads to the inch. This works in two bearings 4 inches apart, one of which has an inside screw corresponding to that upon the spindle. At a point midway between the two ends of the cylinder a pinhole, H, is drilled, and behind the hole a selenium cell, S, is fixed. One terminal of the selenium cell is connected (through the spindle and stand of the instrument) with the negative pole of a battery B', the other with the line wire, M, to the distant station. The receiving instrument, X, contains a similar brass cylinder, similarly mounted. A platinum point, P, presses gently upon its surface, and is connected both to the line wire and, through a variable resistance, R, with the positive pole of a local battery, B, the negative pole of which is connected through the galvanometer, G, with the cylinder. A wire or earth connection, N, between the negative pole of the local battery and the positive pole of the other, completes the arrangement.

To prepare the instruments for work the cylinder of the transmitting instrument is brought to its middle position and a picture not more than 2 inches square is focussed upon its surface by means of a photographic lens, L. The hole, H, in the cylinder is then brought to the brightest point of the focussed picture, and a scrap of sensitised paper being placed under the platinum point of the receiver, the variable resistance is adjusted, so that the two opposite currents through the paper neutralise each other. When

Fig. 3.



this is accomplised the two cylinders are screwed back as far as they will go, the cylinder of the receiver is covered with sensitised paper, and all is ready to commence operations.

The two cylinders are caused to rotate slowly and synchronously. The little hole in the transmitting

Fig. 4.

Image Focussed upon Transmitter.

Image as Reproduced by Receiver.

cylinder will in the course of its spiral path cover successively every point of the focussed picture, and the amount of light falling at any moment upon the selenium cell will be proportional to the illumination of that particular spot of the picture which, for the time being, is occupied by the pin-hole. During the greater part of each revolution

the platinum point will trace a uniform brown line upon the prepared paper, but when the pin-hole happens to be passing over a bright part of the picture, this line is enfeebled or broken. The spiral trace by the point is so close as to produce, at a little distance, the appearance of a uniformly coloured surface, and the breaks in the continuity of the line constitute a picture which, if the instrument were perfect, would be a counterpart of that projected upon the transmitter.

The pictures upon which I have hitherto operated have been mostly simple designs, such as diamonds and squares cut out of thin metal, and projected by a magic lantern (see Fig. 4). But the instrument is in its earliest stage of infancy. It is at present hardly a single month old, and I regret to say that since its birth it has been shamefully neglected, circumstances having prevented me from giving it even the ordinary care and attention which all young creatures ought to receive. Nevertheless, I cannot but think that it is capable of indefinite development; and should there ever be a demand for telephotography, it may in time turn out to be a useful member of society.

ON THE

VENTILATION OF HALLS OF AUDIENCE.*

By ROBERT BRIGGS,
Member of the American Society of Civil Engineers.

(Concluded from p. 8.)

Any man may warm himself as he pleases. It is impossible for a number of men to tell one man what will please each of them individually, and for that one man to please them all. It is not the provision of means of control that will secure the wished for result. With every appliance failure is certain, unless those appliances pass into the hands of the persons to be warmed themselves. The neglect of this essential condition has led to repeated failures, until there is a popular belief that no ventilating apparatus can be successful, and there exists a general preference either for direct steam heating; where an occupant of a room can manipulate the cocks or valves to his own liking, or for mere current warming; where opening or closing a register, also by any person in the room, controls the heat supply satisfactorily, when no importance is attached to the air thus adventitiously furnished or closed off. Only hospitals, or jails, or orphan asylums are happily ventilated, regardless of the volition of the sufferers, but greatly to the delight of ventilation doctors, whose experimental results are pleasant to contemplate.

While commenting thus freely upon the drawbacks of previous efforts, it is a suitable requirement upon the fault-finder that he should offer a remedy; and a remedy will now be proposed, which is: That to the engineer, or persons in charge of the apparatus, should be delegated the running of the same mechanically, in a defined way, without his or they assuming the regulation of the temperature of comfort in any room or hall, or part of a room or hall, where the magnitude of the same admits of division into parts. The temperatures desired or attained being positively controlled, within certain limits, by the occupants, or by representatives of the occupants, such as floor officials or ushers, in the rooms or halls. The limits of temperature proposed are 50 degrees for the lowest and 80 degrees (possible) for the highest. The supply of air at any one time should be constant and invariable, so that the equilibrium of distribution will not be disordered by the closing-off or wide-opening of registers for admission of air—the usual process for controlling temperatures with heated currents at present.

The arrangement of apparatus to effect the foregoing, becomes necessarily a matter of original plan and construction, and is as follows: The boilers, fan engine, and fan may be assumed, for convenience of running, as well as for better and simpler construction, to be placed in juxtaposition in vaults, at any desirable point about the buildings or grounds. Where the grounds near the building fall away, so that the boiler can be located above ground, and yet below the levels of the coils, this disposition of boiler is preferable. One of the advantages of the proposed method is, that except the cost of ducts and mains, the placing of boilers some distance from a building, say some 300 or 400 feet, is not objectionable.

When the desirable level for the boilers, with regard to the coils, for direct return of condense water without force, cannot be had, the return mains can descend to some separating recipient, where the condense water can be trapped-off to a hot well from which the boilers will be fed by a pump; or the coils may be trapped separately or in clusters, and their condense water taken by return mains to the hot well; or the coils may be trapped-off, and the hot condense water wasted; or yet, again, the return mains with regular descent may carry the condense water to a *closed hot well*, placed below the boiler level, under the boiler pressure, from which it will be elevated by a *closed pump* to supply the boiler.*

The main duct should be dry, air-tight, and closed as a passage way, absolutely without openings into rooms, vaults, or general passages, excepting only such doors as may be necessary to give access to the duct for the purposes of the apparatus. Every precaution should be taken to make the main duct *inconvenient* as a thoroughfare. This main duct, in the arrangement of apparatus here proposed, may be carried under ground or under floors, anywhere amongst the foundations or cellar walls of the building; only prescribing that it shall be well built in smooth finished masonry, without angles, dry, air-tight, and closed. Ducts smaller than 12 square feet sectional area may be built of thin galvanised iron, or may be built of wood (with narrow, 3-inch wide boards, tongued and grooved, mill-planed both sides), and lined with light sheet tin, with soldered joints. The wood-work of ducts need not be expensive, but it should be substantial. While small ducts or branches can be cheapest made of thin galvanised iron, in permanent structures, brick-work ducts, with arched or slate-covered roofs, of all sectional areas, branch ducts included, is the best construction. Coil chambers should be built in the manner, and of similar materials, described for ducts.

Returning to the arrangement of apparatus:—There is to be constructed either directly in advance of the fan chamber or close behind it, connecting to the main duct, an *auxiliary coil chamber* to hold an auxiliary heating coil. This auxiliary heating coil should be built in at least four separate sections (with perhaps a larger number for an extensive apparatus), and this coil should, in its aggregate of surface, have enough to heat the entire volume of air required for winter ventilation from zero (or from the supposable lowest temperature of winter) to 50 degrees. Besides this sectional arrangement of the coil, it (the coil) should be so placed in the coil chamber that the air can be passed or by-passed, through or around any one or other or all of the sections, under the regulation of sliding doors or of louvered blinds, so that not only complete but instantaneous control of the heat of the entering air can be had.

With the use of these means of control of the heat of the air entering the ducts, to meet every temperature of the external air, the duty of the engineer so far as relates to the *heat* in the building (for the most part) ceases. He will be required to see at all times, when the outside temperature ranges below the limit of 50 degrees, that the air passing into the main duct has a constant temperature of 50 degrees.

* A Paper presented to the American Society of Civil Engineers, January 26, 1881.

* This last very valuable improvement in the arrangement of return mains was proposed and introduced by W. E. Worthen, M.A.S.C.E., of New York. It presents the same advantages, as regards the "air difficulty," that is found in direct return to the boilers.

This temperature offers great advantages in the transmission of air-currents. It allows them to be carried under ground, in cellars, near foundations and under floorings, to any desirable distance, without loss or gain of heat in the transmission. It places all the local coils in the building on an equality in the demand upon them to supply hot or heated currents. It will be found that half the heating surface for the entire building will be demanded in this auxiliary coil, and that this surface will be peculiarly efficient, because of the great difference between the temperature of the coil surface and that of the effluent air from the coil. With the reduction of dimension of the local distributing coils, a corresponding reduction of dimension of flow- and return-mains will be permissible. And an advantage of the highest importance is yet to be stated; all risk of freezing up the return-mains or the lower pipes of the local coils (or occasionally an entire coil) is obviated, while nothing but positive neglect could allow freezing to occur in one of the sections of the auxiliary coil.

The local distributing coils should, perhaps, be sectional, in not more than two sections for the larger coils, but it is questionable whether any division of these may be necessary, although the writer would advise it in construction. These coils should be in chambers arranged for the air to be passed or by-passed, through or around them, by the regulation of slides or valves *to be placed under the control of the occupants of the room or of the officers or ushers in a hall.* The means for regulation should be solely in the rooms or halls themselves, and any gradation of temperature of entering air from 50 to 80 degrees should be instantaneously commanded, without, however, varying the quantity of air regularly supplied. If, with these provisions, by any accident or neglect the extreme of heat or of cold be allowed in the air supply for a short time, the effect will not be serious, for the instant restitution to what the occupants of a room may deem their temperature of comfort is feasible. The settlement of degrees of discomfort amongst the number occupying a room will have to be effected by tolerance, much as the fresh air is got in a railway-carriage, where there is no one to blame but the passenger when a window is opened or closed.

In halls it is manifestly proper that the floor should be separated in divisions, each having its own supply of air, so that the local regulation may meet not only the small differences of local requirement which always occur, but also the differences of individual demand of equally general, and even more urgent, occurrence. The galleries of halls have not merely a small difference in requirement, but at all times they demand two or three or even more degrees *less* temperature for entering air than the floors. In some cases, as in the Senate Chamber or the Hall of Representatives at Washington, and generally in all legislative or council chambers, the galleries are occupied by a crowd of spectators, clothed, in cold weather, in heavy outer garments, while the floors must be comfortable for the members, who are by no means crowded together, in usual indoor clothing. At evening sessions when gaslights are required, the increase of temperature therefrom will be found mainly in the galleries, and it then becomes essential to supply them with cooler air than the rest of the hall. It is a consequent necessity for the successful ventilation of halls that the gallery supplies of air be distinct and separate from those to the floor; and it is much better to arrange for these supplies in separate divisions, one, if not two, to each side of the hall.

The duty of the engineer of the apparatus, so far as the local coils are concerned, will require him to put in use one or both sections of such coils to meet the demand of the season or day as regards mere warming and positive heating. Beyond this he has, whenever the external temperature is below 70 degrees, only to see that each coil is supplied with steam, and in satisfactory operation as a steam coil, under full boiler pressure. With this, and with his charge of the temperature derived or proceeding from the auxiliary coil, his responsibility for heating the building in cold weather ceases. As the weather becomes warmer in any year, and when the external temperature reaches 50 degrees, the auxiliary coil is thrown off. At 65 to 70 degrees the local coils cease to be operative, and thereafter the engineer, running the fan at double rate when summer ventilation is required, supplies to such hall (the ventilation of which was based on 10 cubic feet of air per person per minute) the maximum of 20 cubic feet, which quantity will be found nearly all that can well be delivered amongst a crowd, where each person occupies say 4 square feet of floor space, or the average theatre allowance.

Economy in running an apparatus must always be considered in planning the same, and no building can be *ventilated* to the full extent continuously, whether its hall be occupied or not, with any proper regard for expenditure. It follows that, notwithstanding what has been said about exonerating the engineer or director of the control of the heating, there must yet be left, with these persons or one of them, the means of reducing the air supply to meet the real necessities of use or vacancy,—of complete or partial occupancy. This may be effected in part by the running of the fan, but it will be found necessary to provide for regulation of air delivery by closure of ducts or branches to some extent. As the local coil surfaces are unalterable, the effect of employment of a greatly reduced volume of air at times will be to enable them to give currents of much higher temperature than 80 degrees.

Thus in a hall with 1200 people, at a minimum of 10 cubic feet per person per minute, we have 12,000 cubic feet per minute. If the local coils can take this air at 50 degrees, and heat it to 68 degrees, which may be supposed to give 70 degrees in a room in moderate weather, and if the same local coils can take this air at 50 degrees and heat it to say 75 degrees in the coldest day (the 80 degrees heat from local coils is supposed in this case to warm up the room after it may have been chilled for want of heat), and also to give 70 degrees in the room, it is evident that, reducing the quantity of air to 1200 cubic feet per minute, these same local coils are sufficient in extent to carry the 1200 cubic feet from 50 degrees to over 125 degrees in the same minute of supply, and at this temperature the room will be warmed to 70 degrees against zero out of doors, at greatly less expenditure of fuel. For in one case there is wasted of vitiated air 12,000 cubic feet which had been taken at zero and allowed to escape at 70 degrees, while in the other case only 1200 cubic feet, taken also at zero and escaping at 70 degrees, is demanded in effecting the heating.

This possibility of economising in the working of every system of ventilation is the bane of all methods. Ventilation is not economic as a process of warming. In many instances, after a demonstration of successful ventilation, the working of the apparatus is permitted to degenerate to the barest warming. There is demanded a conscientious persistency in maintaining a thorough ventilation, where the warming can be made satisfactory without it, that surpasses the moral appreciation of a money-getting manager or of an economic official.

In presenting this optimist view of the subject of practical ventilation of halls of audiences, it must be accepted as indicating the path of advance, not as demonstrating the impropriety of advance. No expenditure is justifiable which cannot have the assertion of necessity; nothing surpassing the admitted wants of society will be appreciated or willingly paid for. The current belief and faith in the necessity for purer air in halls must be entertained by the audiences before the expenditure for provision or of maintenance of ventilating apparatuses can be warranted. It is sure that people do become less tolerant to the closeness and odours of halls, court-rooms, school-houses, year by year. This is evidenced by the extravagant schemes of sanitation of such places on the one hand, and by the boasts of impossible accomplishments with wholly incompetent means on the other, that find so frequent publica-

tion. It has been the purpose of this paper to set forth the least quantity of air supply compatible with relative purity in the air of an occupied hall, and then, without gloss or extenuation, to set out the difficulties and costs in obtaining this least quantity, and the inconvenience and discomfort attendant, so that they shall all be appreciated as incident to the problem of ventilation.

Above all, in the effort to give or establish practical limits for the necessities of ventilation in halls of audiences, which can with safety be aspired to at this present time, and with justice be demanded by the community from all those who control the management of audience or session rooms, it is not wished to be misunderstood by supposing that this paper has been, or is, advocating the dispensing with any real demand in quantity or quality of the supply of fresh, pure air. Compliance with the present *system of ventilation* of hot-air furnaces, which *system* is merely heating to requisite intensity, with adventitious supply of air, is as far from the ideal of perfection as the scheme of giving to the occupant of a hall the healthful air of the mountains, with the freedom and volume of the west wind, is from the possibility of construction or of operation. Little by little modern society appreciates the conditions of healthful, civilised existence. The removal of cause of offence is the first requisite of sanitation, and it is the first requisite of ventilation. Our tolerance of personal uncleanness in small ways, and in large ones also, goes far to account for the offensiveness and unhealthiness of many places of public gathering. Arguments on this point, and social enforcements of regulations in this regard, in theatres, court-rooms, galleries of public halls, school-rooms, public conveyances of all kinds (especially the latter), will be more efficient than the indoctrinating of surmounting the difficulty by gales of fresh air, furnished regardless of comfort and expense.

Finally, after establishing the *requirements* for necessary and indispensable ventilation of audience halls and of audiences, it becomes the indispensable preliminary that the original planning and subsequent erection of the buildings shall provide suitable rooms for apparatus, together with ducts, distributing passages, and flues, in order to render available the methods of the mechanical engineer; by which methods ventilation, with comfortable heating, can now be effected with controllable, positive, and satisfactory result.

CORRESPONDENCE.

ON A NEW METHOD FOR THE ESTIMATION OF NITRATES IN POTABLE WATER.

To the Editor of the Chemical News.

Sir,—Mr. J. West-Knights read a paper before the Society of Public Analysts with the above heading on the 16th of March last. Allow me to state that it is not a *new method*, but only a slight modification of Mr. Edward Nicholson's process, as described by him in the *Madras Monthly Journal of Medical Science*, for May, 1871, and also in the Chemical News, vol. xxv., p. 89.—I am, &c.,

William Johnstone.

King's Lynn, July 4, 1881.

THE ACTION OF NITRIC ACID ON METALS.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 284, I read a note by M. E. Maumené "On the Action of Nitric Acid on the Metals." According to M. Maumené's theory, the formation of ammonia by the action of tin on nitric acid takes place according to the following equation:—

$$14Sn + NO_3(HO)_{10} = 8SnO + 6Sn + NH_3 + 7HO.$$

Now since only 8 equivalents of Sn take part in the reaction, why use 14? What *rôle* do the other 6 parts of Sn play?

I shall be much obliged to my learned friend if he will explain this obscure point of his "*Théorie Générale*."—I am, &c.,

Dr. D. Tommasi.

Florence, June 27, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 22, May 30, 1881.

Discontinuous Phosphorescent Spectra Observed in High Vacua.—W. Crookes.—This paper has been communicated in full to the Royal Society. M. E. Becquerel remarked that he had previously observed some of the facts observed by Mr. Crookes. (See *Ann. de Chimie et de Physique*, 3rd series, vol. lvii., p. 40.)

New Interruptor for Induction Coils.—M. Deprez.—The author states that the apparatus of M. Ducretet (*Comptes Rendus*, May 23) is merely a form of that which he produced nearly a year ago, and laid before the *Société de Physique*. The elasticity commonly given to the organs of the ordinary interruptor, and the amplitude of movement which it consequently possesses, are injurious to the effects proposed to be obtained.

The Conic Mirror: A Reply to M. Pifre.—M. Mouchot.—The mirror is an apparatus for concentrating the heat of the sun's rays. The author contends that its action is more powerful than M. Pifre is willing to admit.

Discussion of the Theory of the Three Fundamental Colour-Sensations of the Eye. Distinctive Characters of these Colours.—A. Rosenstiehl.—The fundamental colours possess the following properties:—By their mixture, two and two, they produce all the colours perceptible to our eyes. They produce at the same time the sensation of whiteness to a less degree than the other colours. The sensation of pure whiteness depends on the equal excitement of the three fundamental sensations. As regards complementary colours he finds that the colours situate on the one and the other side of a primary colour, and which are to the eye equidistant, have their complementaries so close together that it is difficult to distinguish between such as are consecutive.

Essence of Wild Thyme.—P. Febve.—The author has obtained from this oil a cymene, $C_{20}H_{14}$, and a thymol, $C_{20}H_{14}O_8$.

Geological Microzymas.—Reply to MM. Chamberland and Roux.—A. Béchamp.—The author refers to former experiments in which he has obtained alcohol, lactic, acetic, and butyric acid by means of the microzyma of chalk.

Vanadiate of Lead and Copper from Laurium.—F. Pisani.—The mineral is a cupriferous eusynchite, containing equal equivalents of lead and copper, as in psittacinite and mottramite.

Journal für Praktische Chemie.
Parts 19 and 20, 1880.

Formation of Urea in the Animal Organism.—E. Drechsel.—The author shows that urea is formed from ammonium carbaminate.

Nos. 1 and 2, 1881.

Researches from the Chemical Laboratory of Prof. A. Saytzeff at Kasan.—These consist of a memoir by

B. Sorokin on the constitution of diallyl, and a paper by W. Lebedinsky on allyl-di-iso-propyl-carbinol and its product, β-di-iso-propyl-ethylen-lactic acid.

Contributions to the Chemistry of the Chrom-ammonium Compounds.—O. J. Christensen.—The author gives a very full account of roseo-chrom-hydrate, the corresponding chloride, bromide, iodide, sulphate, nitrate, platinum bromide, sulphato-platinum chloride, sulphato-platinum bromide, mercuric chloride, bromo-chromate, the double cyanides of roseo-cobalt and roseo-chrome with iron, cobalt, and chrome. He mentions that whilst the two atoms of chlorine in chloro-purpureo-chrome chloride are most intimately combined, and are not precipitated by silver nitrate without the aid of heat in the roseo-chloride, all the chlorine is precipitated by silver nitrate in the cold. In an appendix the author treats of the preparation of chloro-purpureo-chrome chloride.

Changes of Colour in the Solutions of the Salts of Chrome-oxide.—G. Doyer van Cleef.—The author concludes from his experiments that the neutral chrome salts, which dissolve with a violet colour, undergo a gradual decomposition in solution, and that the changes of colour of the chromic salts when heated are due to a similar decomposition carried to a greater extent.

Loss of Water by Certain Salts Chromic of Oxide.—G. Doyer van Cleeff.—In chromic sulphate there is no marked difference between the mode of combination of twelve of the mols. of crystalline water and of the remainder.

Silver in Commercial Bismuth and Certain Connected Phenomena.—R. Schneider.—It appears that distinct traces of silver are to be found in many samples of the commercial preparations of bismuth. Pure oxide of bismuth free from silver is not sensitive to light.

History of the Oxidations in the Animal Body.—M. Nencki.—The author submits the researches and conclusions of Hoppe-Seyler to a severe criticism.

Nos. 3 and 4, 1881.

Crystalline Albumen in Pumpkin Seeds.—Dr. G. Grübler.—Pumpkin seeds contain an albumen which may be easily obtained in well-developed octahedral crystals. The proteine contained in the seeds consists chiefly of such crystals. Crystalline albumen is distinguished from the amorphous variety by a far smaller proportion of ash and of phosphoric acid, and by a higher proportion of carbon, nitrogen, and sulphur.

Formation of Dihydro-anthranol and Anthracene from Anthraquinon.—Dr. H. R. von Perger.—Dihydro-anthranol is obtained from anthraquinon by the action of zinc powder and ammonia.

The Compounds of the Mono- and Bi-basic Fatty Acids with the Phenols.—M. Nencki and N. Sieber.—By the alternate application of mono-basic fatty acids and phenols with zinc chloride an entire series of aromatic oxy-ketons have been formed. The authors have also obtained a succinyl fluoresceine by heating hydrated succinic acid and resorcine along with zinc chloride or with strong sulphuric acid.

Benzol and Dipropargyl. Confirmation of Theory as regards the Formation-heat of the Hydrocarbons.—Julius Thomsen.—The liberation of heat on the formation of hydrocarbons of constant volume from gaseous carbon and hydrogen is a multiple of a constant magnitude, about 14,700 cals. The single combination of two carbon atoms yields the same quantity of heat as the combination of one hydrogen atom with the atom of carbon. The double combination of two carbon atoms effects the same liberation of heat as the simple combination. The threefold combination of two carbon atoms occasions no liberation of heat. The liberation of heat on the formation of a hydrocarbon from amorphous carbon and gaseous hydrogen, the volume remaining constant, may be calculated according to the formula—

$$(C_nH_{2m}) = -n\,d + (2m + x + y)r,$$

x and y denoting the number of the single and double valences. The constant difference between the combustion-heat of two adjacent members of a homologous group of hydrocarbons is 159,840 cals. The great difference between the combustion-heat of the isomeric hydrocarbons benzol and dipropargyl as deduced from the author's theory is confirmed by the experiments of Berthelot and Ogier.

Supposed Isomeric Æthans.—Julius Thomsen.—The æthans obtained from zinc ethyl and by the electrolysis of acetic acid have an equal combustion-heat, 373,250 cals. Ethyl-hydride and dimethyl are probably identical.

Thymo-quinon-chlorimide and its Transformations.—Dr. M. Andresen.—This memoir does not admit of useful abstraction.

Researches from the Laboratory of Prof. A. Saytzeff, at Kasan.—This paper describes β-dipropyl and β-diethyl-ethylen-lactic acids, and the oxidation of allyl-dimethyl-carbinol and diallyl-carbinol with potassium permanganate.

Nos. 5 and 6, 1881.

Determinations of Chemical Affinity (Third treatise).—Dr. W. Ostwald.—The author investigates the circumstance that the monobasic salts in presence of their neutral salts have a greater solvent power than without them. This fact is the more remarkable since, according to present thermo-chemical, volume-chemical, and optico-chemical researches, it was not to be expected.

Contributions to the Chemistry of the Cobalt-ammonia Compounds.—S. M. Jörgensen.—This memoir is devoted to the nitrato-purpureo-cobalt salts, the composition and reactions of which are described in detail.

Researches from the Chemical Laboratory of Prof. Alex. Saytzeff, at Kasan.—These consist of a memoir by A. Semljanitzin on allyl-methyl-propyl-carbinol, and on its derivative, β-methyl-propyl-ethylen-lactic acid; a paper by K. Rjabinin on the methyl- and ethyl-ethers of diallyl-carbinol, and on β-methoxyl-glutaric acid obtained from the former; a memoir on the formation of β-methyl-oxy-glutaric acid from diallyl-methyl-carbinol, by B. Sorokin; a paper on the transformation of the oxy-valerianic acid obtained from allyl-methyl-carbinol into iso-propyl-acetic acid, and on the β-iso-dipropyl-acetic acid, by Al. Schirokoff; and studies on the calcium and barium salts of the diethyl and methyl-propyl-acetic acid.

Behaviour of Argentiferous Bismuth on Re-crystallisation.—Clemens Winkler.—The author admits an error in a former paper.

Myko-protein.—F. Schaffer.—Myko-protein belongs to the true albumens, and is the most sparingly soluble of all the acid albumens in the solutions of neutral salts.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 8, February 24, 1881.

Method of Distinguishing Spurious Honey.—A solution of 20 parts of honey in 60 parts of water mixed with alcohol gives a heavy white precipitate of dextrine if glucose has been added, whilst genuine honey if treated in the same manner merely becomes milky.

No. 9, March 3, 1881.

Source of Selenium.—At Cachenta, in the Province of Mendoza, in the Argentine Republic, there occurs an ore containing 28·8 per cent of selenium along with silver, copper, lead, iron, tellurium, sulphur, silica, and alumina. The proportion of tellurium is higher than that of sulphur.

Ten pages are devoted to an article on the alleged liquefaction of the blood of St. Januarius at Naples,

which it is maintained is a miracle not to be explained by science!

No. 10, March 10, 1881.

True Chemistry.—E. Maumené.—The author sums up his paper in the following words:—"Eight new acids in an operation which was believed to be known because it had already furnished a ninth." Everyone knows that barium hyposulphite and iodine gave Fordos and Gélis the tetra-sulpheate (tetra-thionate) of barium. These chemists thought this the only possible compound produced by the two bodies. The real action is not what Fordos and Gélis thought, and is accompanied or followed by other reactions, according as an excess of iodine or of disulphubate (hyposulphite) is employed. The new acids are said to be S_2O_3, S_6O_8, S_8O_{11}, S_3O_3, S_3O_2, S_6O_9, S_4O_6, and S_3O_4.

Revue Universelle des Mines, de la Metallurgie, &c., Tome 9, No. 1, January and February, 1881.

This number contains no chemical matter.

MISCELLANEOUS.

Royal Polytechnic Institution.—Mr. W. Mattieu Williams, F.R.A.S., F.C.S., author of "The Fuel of the Sun," "Through Norway with a Knapsack," &c., has been appointed to the management of the above Institution, and commences his duties forthwith.

The Stevens Institute of Technology.—At this establishment there has been recently opened a new workshop for the practical study of mechanical engineering. It occupies a building 80 feet by 50 in width, with a high open roof and double galleries. It has been fitted up, at his own cost, by Professor H. Morton, the President of the Institute, and is well filled with the finest specimens of steam-engines, lathes, planers, drills, grinding machines, &c., and is well illuminated with the electric light. The new workshop was formally opened on the 14th of May last, when speeches were delivered by President Morton, Mr. Coleman Sellers, and others. Mr. Sellers spoke of former efforts made for the training of mechanists, when it was thought sufficient to add shop practice to the regular school-course, and referred to a so-called "Russian system" which "seeks to instruct without trying to construct," but which he did not define or explain, though he declared that by its means skilled workmen are trained in a shorter time than by any other method with which he was familiar. President Morton explained that the object of the Stevens Institute was to train, not journeymen mechanics, but mechanical engineers, and gave a sketch of the educational curriculum requisite.

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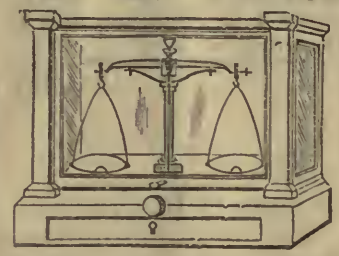

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THE CHEMICAL NEWS

Vol. XLIV. No. 1129.

COLLIERY EXPLOSIONS.*

By F. A. ABEL, C.B., F.R.S., President of the Institute of Chemistry, Chemist to the War Department, &c.

(Continued from p. 18.)

II.

The influence which may be exerted by deposits of coal-dust in mines upon the magnitude of fire-damp explosions, to which attention appears first to have been directed by the observations of Faraday and Lyell in 1845, was made the subject of some experiments in France in 1867 by M. Verpilleux, who came to the conclusion that coal-dust plays an important part in coal mine explosions. The subject was further and more fully examined into in France by the aid of experiments on a small scale by M. Vital in 1875, in connection with an enquiry into the nature and cause of an explosion which occurred the preceding year in the Campagnac Colliery, and in a part of that colliery where no fire-damp had ever been detected On this occasion an examination for gas had been made by the overman with the Mueseler lamp just before firing a shot. After the first shot a scond hole was charged: the fuze having been ignited, the men then retreated, when, after a few seconds, a violent explosion occurred, and the men saw a *large body of red flame* advancing upon them. After examining the nature of dust collected in the mine, and instituting some special experiments upon a very small scale for the purpose of ascertaining whether, and to what extent, the flame from a small charge of powder was lengthened, when projected, like the flame from a blown out shot, into air containing fine coal-dust in suspension, M. Vital concluded that very fine coal-dust, very rich in volatile (inflammable) constituents, will take fire when raised by an explosion, and that portions of the coal are successively decomposed, yielded explosive mixtures with the air, whereby the fire is carried along; the intensity or violence of the burning being much influenced by the physical characters (fineness, &c.) of the dust. He also pointed out that an explosion of fire-damp, while taking place almost instantaneously, inflames or decomposes a small quantity of coal-dust raised by its explosion, and that explosive action is thus propagated when the fire-damp explosion ceases. Soon after M. Vital's investigation of the subject Mr. W. Galloway commenced a series of valuable experiments upon a larger scale, with the view of investigating the influence of coal-dust in colliery explosions, and the results were communicated by him to the Royal Society in two papers, in 1876 and 1879. The conclusions to which Mr. Galloway was led by the experiments described in his first paper were to the effect that a mixture of air and a particular coal-dust which had been made the subject of chemical examination and practical experiment, was not inflammable at the ordinary pressure and temperature, but that the presence of a very small proportion of fire-damp in the air, the existence of which could not be detected with the Davy lamp by the most experienced observer, rendered this dust inflammable, and caused it to burn freely with a red smoky flame. From this it was inferred that an explosion, when originated in any way whatever in a dry and dusty mine, may extend itself to remote parts of the workings, where the presence of fire-damp was quite unsuspected.

In his second paper Mr. Galloway demonstrated that the return air of a mine in which a considerable quantity of fire-damp is emitted by the coal, as in the Llwynypia Colliery (where the air-return was estimated to contain approximately 2 to 2½ per cent), may be rendered inflammable by the addition of coal-dust. He also described experiments by which it appeared to be demonstrated that the flame developed by an explosion of fire-damp in a particular part of a mine might be propagated, at any rate to some extent, by coal-dust raised and suspended by the explosion in the air travelling through a mine, even in the complete absence of fire-damp in this air.

The apparatus devised by Mr. Galloway for the latter experiments was very ingenious, but it appears open to question whether small quantities of fire-damp did not find their way, before the explosion, from that part of the apparatus where the gas-mixture was prepared and fired, into the channel where coal-dust was raised and into which the flame of the explosion was projected.

Extensive experiments have been carried on, and are still in progress, at Harton Colliery, under the direction of Mr. Lindsay Wood and Professor Frere Marreco, and also at the Broad Oaks Iron Works by a committee of the Chesterfield and Derbyshire Institute of Engineers, upon the behaviour of air containing coal-dust in suspension, and moving at different velocities, when exposed to the effect of a lamp or gas-flame, or of the flash produced by firing a small charge of gunpowder from a pistol or cannon in the dust-laden atmosphere. The apparatus used in these experiments and in some of those of Mr. Galloway are alike in general construction, differing, however, in regard to dimensions and some other details. They consist of long wooden boxes, channels, or galleries, fitted with windows to serve as observing stations; with relief doors, flaps, or other suitable arrangements for minimising damage to the apparatus from explosions; with appliances for maintaining air currents at different velocities, and supplies of air and of coal-gas or fire-damp in fixed proportions; with arrangements (in some instances) for raising the temperature of the air which passes through the box or channel, and means of admitting supplies of coal dust into the apparatus in such a way that they shall be readily carried forward in suspension in the current of air and gas. Attempts have also been made, in connexion with these apparatus, to obtain some comparative records of the force exerted by different explosions. The height and width of the channels or galleries used by the different experimentors have varied from 12" × 6" to 18" × 15". Their length has differed greatly: Mr. Galloway employed channels about 19 feet and 80 feet long; in the Harton experiments the length of the gallery was 42 feet from the dust hopper, and it had a parallel return gallery 39 feet long; in the Chesterfield apparatus the length of the gallery from the hopper was nearly 62 feet.

It does not appear that in the numerous experiments made at the Harton Colliery by exposure of naked flames in currents of air laden with coal-dust, and by firing small cannon (representing blown-out shots), placed in various positions in such air currents, any decisive indication has been obtained of a propagation of flame by the coal-dust. On the other hand, I believe that the Chesterfield Committee consider they have obtained unquestionable evidence that flame will travel in a mixture of coal-dust and air in the absence of any trace of fire-damp.

At the Garswood Hall Colliery of Messrs. Smethurst, Hoyle, and Grime, at Brynn, near Wigan, a copious and continuous supply of pit-gas is brought to the surface, and has been utilised by Mr. William Smethurst in many valuable experiments on the behaviour of different safety lamps in explosive gas mixtures, with the employment of apparatus similar in general construction to those just described.

The Royal Commission on Accidents in Mines have availed themselves of this supply of gas, and of special conveniences and personal aid kindly placed at their disposal by Mr. Smethurst, to institute extensive experiments on the comparative merits of different safety-lamps. For

* Report on the Results of Experiments made, with Samples of Dust collected at Seaham Colliery, in compliance with the request of the Secretary of State for the Home Department, conveyed by letter dated November 4th, 1880.

this purpose they had an apparatus constructed of the kind above referred to. The particular purpose for which it was needed rendered it only necessary to provide a comparatively short channel or gallery, and the general fittings were of a simple nature, but great pains were taken to secure accuracy and uniformity in the velocity of the air-currents employed, in the proportions of gas used with the air, and in the intimacy of their mixture. The Commission satisfied themselves that, in these important respects, the apparatus used by them left little to be desired.

Into this apparatus various modifications have been introduced for the purpose of rendering it suitable for the experiments which I desired to carry out with the samples of Seaham dust, and for the more extended experiments with coal-dust upon which the Commission are now engaged.

The gallery or channel (one foot length of which has a capacity of about one cubic foot) has been increased in length so that the distance between the hopper, or drum-sieve, used for delivering the dust, and the vertical shaft at the end, into which the steam-jet passes, whereby the current is established and maintained at the desired velocity, is 28 feet. In order to raise the air-current in the gallery to a temperature similar to that of the atmosphere in colliery workings, the air supply is drawn through the tubes of a large tubular boiler, which are heated by steam so as to obtain the current, passing at velocities which have ranged from 100 to 1000 feet per minute, at temperatures of 75° to 85° Fahrenheit, even in the severe winter weather during which a portion of these experiments have had to be carried on.

The following sources of heat and flame were employed in the experiments made in this apparatus with the dust samples from Seaham Colliery :—

1. An uncovered Davy or Mueseler lamp, with a long wick, so as to furnish a large flame, which, when exposed to the more rapid currents, was protected from extinction by a low screen of sheet metal.
2. A wide gas jet, supplied with pit-gas and furnishing a broad flame, from 3 to 5 inches long. This was also protected by a shield reaching just above the gas-jet.
3. A small cannon, fitted with an electric fuze in the breech, and loaded with charges of 80 grains of fine grain powder. A simple plan of confining the charge or closing the muzzle of the cannon was employed, by which uniformity in the force of explosion of the powder-charges was secured. In some instances the muzzle of the cannon was opposed to the current, in others its position was reversed. In some experiments these little cannon were employed singly, in others, two cannon were placed in the gallery at some distance from each other, their muzzles facing, and were fired one after the other, either in quick or in slow succession.
4. A charge of 400 grains of powder, unconfined, and placed on the floor of the gallery, the charge consisting of 390 grains of compressed mining powder and 10 grains of sporting powder for the purpose of inflaming the former rapidly. The charge was ignited electrically.
5. A charge of 200 grains of compressed powder, including a small quantity of sporting powder, arranged as No. 4.
6. A charge of 400 grains of sporting powder, arranged as No. 4.
7. A charge of 300 grains of loose gun-cotton, placed upon the floor of the gallery and fired electrically. This particular explosive agent was employed because its ignition suddenly developed a large volume of flame similar in character to that produced by the ignition of an explosive mixture of fire-damp and air.

The pit-gas which issues from the Wigan 9-foot mine, and with which the experiments at Garswood Hall Colliery were made, is what is commonly called a sharp gas, and of the kind known as *silver gas*. Its presence in air, when in sufficient abundance, is indicated by a lengthening of the flame of a safety lamp, but lower proportions, such as would be indicated by the production of small blue caps upon the flame of a Davy lamp with some descriptions of fire-damp, afford no such signs of their existence with this gas. The effects upon the lamp-flame of as much as 2·5 per cent of the gas, in air, can only be detected by the most experienced observers.

In experiments made in currents which ranged in velocity from 200 to 1000 feet per minute, mixtures containing 3·5 per cent of this gas were ignited (producing feeble explosions) by a naked Davy lamp flame, sometimes almost immediately upon reaching that part of the gallery where the flame was placed, at others after the gas-mixture had been passing the flame from 5 to 10 seconds, the general ignition of the mixture being preceded by flares which travelled forward from the lamp-flame. In two or three experiments a gas-mixture containing only 3 per cent of firedamp inflamed throughout after the current had been passing some time, but in these instances there appears little doubt that other conditions, to be presently mentioned, determined the inflammation of the mixture. With a current travelling only at a velocity of 100 feet per minute, no effect beyond some elongation of the lamp-flame was produced by a mixture containing 3 per cent of gas; when increased to 3·25 per cent a very faint flickering flame was observed, which was lengthened when the gas was further increased to 3·50 per cent. With 3·75 per cent the lamp-flame became occasionally prolonged into a lambent flame, which increased in size when the gas was increased to 4 per cent, and with a further increase to 4·25 (in one experiment, and 4·5 in another), the flame increased in size rapidly, filling the gallery in front of the lamp-flame, and finally a general ignition of the gas mixture in the whole gallery occurred.

In an apparatus arranged (at Woolwich) for the exposure of mixtures of coal-gas and air, with or without dust, but *perfectly still*, to the effect of flashes of flame (produced by igniting small quantities of gun-cotton electrically), no result was obtained with mixtures of 3 and 4 per cent of gas, and a feeble explosion was obtained with a mixture containing 4·25 per cent. It appears, therefore, that in currents of considerable or moderate velocity, a mixture containing 3·5 per cent of the particular pit gas employed becomes ignited by the flame of a safety lamp, the flame travelling against the current with feeble explosive effect, while, at a low velocity, or in a still atmosphere, from 4 to 4·5 per cent of coal-gas, or of this pit-gas, are required to produce a similar result.

A series of experiments, as nearly as possible comparative in all respects, was made with the 10 samples of dry Seaham dust, conveyed in suspension in currents having in each experiment a velocity of 600 feet per minute, and a temperature of about 80° Fahrenheit. A naked Davy lamp, the flame protected by a screen, was placed in the gallery at a distance of 12 feet from the point where the current met the supply of dust. The latter was always maintained as far as possible at the maximum which could be delivered by the feeding arrangement used. In two or three instances the quantity of dust was comparatively small, and could, therefore, not be maintained for as long a period as in other experiments, but the general results obtained were sufficiently marked to admit of a classification of the dusts as regards the readiness with which they promoted the ignition of such a gas mixture as the naked lamp flame did not exhibit any tendency to ignite before the dust was allowed to mingle with it; or, in other words, as regards the proportion of fire-damp required to impart explosive properties to the mixture of air and dust. What may be termed the *order of sensitiveness* of the dust samples, in reference to the latter point, is represented in the accompanying tabular statement, in which the samples of dust are indicated by their distinctive letters; in the same table are shown the order of richness in coal, and of

fineness of the dust samples as well as their relative position in regard to the extent to which they had been affected by exposure to heat, so far as could be ascertained by the microscopic examination of small specimens.

Table II.

Order of Richness in Coal.	Order of Fineness.	Affected by Heat.	Order of Sensitiveness.
X, K } richest	X, K, S } No great difference.	X, K, M, V } Apparently not.	X K
S			S
V			N
M	O V		M R U V
T	M	N, O } Doubtful	O T
O R	N	S	
U	U	T	
N	T	U	
N	R	R most	

Description of Sample.

X.—From screens.
K.—Floor of curve in stock drift.
S.—No. 1, Engine plane, off props and stones.
N.—No. 3, Hutton seam, south way.
M.—Near Maudlin Engine.
R.—No. 1, Engine plane, off side.
U.—Stone drift, No. 1 pit, 3rd east way.
V.—Beyond end of stone drift, No. 1 pit, 3rd east way.
O.—Old incline floor.
T.—No. 1, travelling road.

The most sensitive dusts, which were also the richest in coal and the finest, produced explosives mixtures with air containing only 2·5 per cent of fire-damp. The next to these in order of sensitiveness, and not greatly different from them, also followed next in order, both as regards richness in coal and fineness, but the one next following, and differing but little in sensitiveness from the preceding one, was the dust which chemical examination showed to be poorest in coal (containing nearly half its weight of non-combustible constituents). This dust, though not so uniformly fine as the preceding samples, was very uniformly suspended throughout the air current which conveyed it; 2·75 of fire-damp sufficed to produce with it a mixture which was exploded by the lamp-flame. Of the other six samples, four ranked closely together, being less sensitive than those already referred to. It will be seen that these differed from each other in regard to richness in coal and the proportions of very fine dust which they contain. Lastly, there were two samples decidedly less sensitive than these; they did not present any very marked difference from or other of the preceding four samples in point of richness in coal, but they could not be so plentifully and uniformly suspended in the air current as the others. These six samples all formed more or less readily explosive mixtures when suspended in air containing 3 per cent of fire-damp.

It will be seen from the tabulated comparative statement that the circumstance of some of the samples having been more or less affected by heat, while others were unaffected, does not appear to have borne any definite relation to the comparative sensitiveness of the different samples. An examination of the specific gravities of the several samples of dust showed that those which were the most sensitive had the lowest specific gravities, containing as they did the lowest proportions of heavier metals foreign to coal (the specific gravity of X was = 1·41, of K = 1·50, and of S = 1·47. But with respect to the other samples, their specific gravities did not show any definite relation to their sensitiveness. Thus, of the two least sensitive dusts, O had a specific gravity of 1·53, while that of T was 1·72, and the sample N, which contained so large a proportion of non-combustible matters, and was third in order of sensitiveness, had the highest specific gravity of all the samples (1·89).

On submitting dusts from other collieries to the same comparative experiments as were applied to the Seaham dust, it was found in the first place that the most sensitive of the latter were somewhat less so than two samples from the Madeley and Leycett Collieries (Fair Lady Pit). A copious flow of one of these in air containing only 2 per cent of gas, and travelling at a velocity of 600 feet per minute, caught fire almost immediately it reached the lamp-flame, and a general ignition of the mixture in the gallery followed very rapidly upon the first flare produced in front of the lamp. Another sample furnished a similar result when the fire-damp amounted to 2·25 per cent. Samples of dust from Blantyre and Newport, Abercarn Collieries, were found to be as sensitive as the most sensitive Seaham samples, while some samples from Penycraig Colliery corresponded in this respect to the second in order of the Seaham samples, but produced sharper explosions than any of those samples, when mixtures of the dust with air containing 2·75 and 3 per cent of fire-damp were inflamed.

Although great pains were taken to render the discharge or flow of the several samples of dust into the gas- and air-mixture uniform in different experiments, some variations unavoidably occurred in the rapidity with which the dust was delivered, and such variations no doubt affected in some instances the rapidity with which the dust- and gas-mixture was inflamed; but repetitions of experiments with one and the same sample of dust showed that the results were generally reliable, and this was confirmed by the close correspondence of those obtained with dust-samples of similar character.

The Leycett samples corresponded closely in chemical character and specific gravity to the Seaham dust collected from the screens; their somewhat greater sensitiveness was, therefore, possibly ascribable to their travelling better and more uniformly in the air-current, and, perhaps, also to physical peculiarities. Indeed, while the richness of a dust in coal, or its greater inflammability, influenced the rapidity and consequent violence of the explosion of dust- and gas-mixtures containing corresponding quantities of fire-damp, the physical characters and mechanical condition (lightness, porosity, and state of division) evidently contribute more than the richness in coal or combustibility of the dust-sample, to determine the comparative readiness with which it brings about the inflammation of a gas-mixture not susceptible of ignition *per se* under otherwise similar conditions, and to regulate the proportion of gas required to produce, with it, a mixture which will ignite and *convey* flame, when coming into contact with flame. This is strikingly illustrated by the fact that the sample of Seaham dust containing the smallest proportion of coal, and consisting, indeed, of nearly half its weight of non-combustible matter, ranked next in sensitiveness to the samples which consisted almost entirely, or chiefly, of coal.

The results obtained with this particular dust led me to try whether the ignition by a lamp-flame of a mixture of fire-damp and air, not inflammable *per se*, would be brought about by suspending it in a fine readily-floating dust which was *quite non-combustible*, and not susceptible of any chemical change by exposure to a high temperature. The powder answering to these conditions which was most readily procurable when this experiment suggested itself was calcined magnesia. A gas-mixture having 3 per cent of fire-damp was allowed to pass a lamp-flame, at a velocity of 600 feet per minute for some time; no result was produced, but on causing it to convey calcined magnesia in suspension long flares of flame were produced within a few seconds of the mixture first passing the lamp, and the inflammation speedily spread throughout the gallery with feeble explosive effect. With only 2·75 per cent of gas, results quite similar were produced, the *general* ignition following, however, less rapidly after the first production of the flares in front of the lamp-flame. With another sample of calcined magnesia, which was not quite so light as the first one, a corresponding result was obtained with a mixture containing 3 per cent of fire-damp.

In a still atmosphere, containing 2·5 per cent of coal gas, one of the most sensitive of the Seaham dusts (K), when suspended in it, produced ignition of the mixture, with no explosive effect. A corresponding result was produced by suspending calcined magnesia in a still atmosphere containing 3 per cent of gas.

It will be seen from these results that the perfectly non-combustible powder, magnesia, is, in its power to bring about the ignition of an otherwise uninflammable mixture of fire-damp or coal gas and air, little inferior to the most inflammable and sensitive of the Seaham dust-samples.

These remarkable results led to the trial of a number of other non-combustible powders or dusts, which are not chemically affected by such heat as they would be exposed to in the flame of a lamp (such as kaolin, powdered flint and other forms of silica, pumice, slate dust, &c.) with results similar to those furnished by the magnesia-dust, but more or less affected by variations in the density and other physical properties of the dusts. In experiments with currents of 1000 feet velocity, the effect of any one of the powders being deposited on the bottom and sides of the gallery, was to cause the *instantaneous* ignition of a 3·5 per cent gas mixture on its reaching the lamp-flame, through the influence of dust particles carried along by the current, and in some instances a like result was obtained with 3·25 and 3 per cent gas-mixtures. From these results it appears that the ignition, after longer or shorter intervals, of currents of gas-mixtures of this kind, when passing a small lamp-flame (as noticed in an earlier part of this Report), is most probably ascribable to the influence of a few dust-particles which become accidentally suspended in the current and are carried into the flame. The instantaneous raising of such small dust-particles to incandescence by the flame must have the effect of localising and consequently intensifying the heat at those points, and the ignition of the gas, greatly diluted with air, may thus be brought about. That such an effect must be magnified when a *cloud* of very fine dust suspended in the gas-mixture passes through the flame, is obvious, and is demonstrated by the fringe of incandescent particles which surround the lamp-flame under these conditions, and thus the action of the dust in promoting the ignition of mixtures of very small quantities of fire-damp with air may perhaps be sufficiently accounted for. From certain phenomena observed in the experiments with non-combustible powders, it appears not improbable, however, that another quite distinct mode of action of the finely-divided and heated solid may operate very importantly, and at any rate contribute, in determining the ignition of gas-mixtures which are not susceptible of inflammation by the application of flame alone.

This subject will receive at the hands of the Royal Commission on Accidents in Mines the further investigation which it demands, but the experiments which have been instituted by me in fire-damp mixtures with the Seaham dusts, and with other dusts (consequent upon the results which the former have furnished), have fully confirmed the facts, already, in part, well established by the experiments of M. Vital and Mr. Galloway, that coal-dust in mines importantly promotes, extends, and aggravates explosions due to fire-damp, by reason of the rapid inflammability of the finely-divided combustible, and of the readiness with which it becomes and remains suspended in air-currents; and that it may also be itself readily brought into operation as a fiercely and rapidly burning, or even as an exploding, agent in mines, through the medium of fire-damp when existing even in a proportion which, in the case of the fire-damp *per se*, would not be attended by danger. The experiments have further demonstrated that *dust* in coal mines, quite apart from any inflammability which it may possess through consisting partly or chiefly of coal (and by which it operates more or less seriously in increasing the magnitude of explosions and the heat and fire developed by them), can operate distinctly, as a finely-divided solid, in determining the ignition of mixtures of only small proportions of fire damp and air, and consequently in developing explosive effects, which, though mild in the first instance, may be increased in magnitude by the coal-dust which the first ignition of the gas-mixture raises and brings into action.

In the experiments with coal-dust, the results of which are given in this Report, it has been shown that as small a proportion as about 2 per cent of fire-damp in air, in currents travelling at a moderate velocity (600 feet per minute) may be brought to ignition by coal-dust, or, what amounts to the same thing in regard to the result, *that small proportions of fire-damp may be instrumental in determining the ignition of, and the propagation of flame by, coal-dust.*

In some experiments made in currents of very low velocity (100 feet per minute) with the most sensitive of the coal-dusts used in these experiments (from Leycett Colliery) it was found that when a mixture containing only 1·25 per cent of gas, charged with the dust, reached the naked lamp-flame the latter became surrounded by a large fringe of flame, filled with incandescent dust particles. When the proportion of gas was increased to 1·5 per cent a long flare was at once produced which soon increased to a large flame, and after a short interval the mixture of dust and air with this small quantity of fire-damp burned from end to end of the gallery.

In his earlier paper communicated to the Royal Society, Mr. Galloway describes a series of careful observations on the effect of various mixtures of fire-damp of a particular kind upon the flame of a safety lamp (which notwithstanding the persevering efforts of many intelligent workers who have endeavoured to establish a practicable and accurate method of determining *underground* the proportion of fire-damp in air, still remains the only expedient by which fire-damp is searched for, and its amount roughly estimated). Those observations demonstrate that it is, to say the least, extremely difficult to detect so small a proportion as 2 per cent of fire-damp in the atmosphere of a mine, and this conclusion has been quite recently confirmed by Mr. Galloway in his evidence at the inquest upon the Penycraig disaster, in which he stated that "it is impossible for any but the most practised eye to detect so small a proportion of fire-damp (as 2 per cent) in the air, and then it is only with the aid of a glass lamp well cleaned, and with a good wick and good oil. The great majority of mining men and all ordinary workmen would pronounce the return air of such a colliery to be *quite free from gas.*"

The correctness of these statements of Mr. Galloway has been confirmed by others having great experience in coal mines, of whom I have made inquiry on this subject.

It appears, therefore, that the proportion of fire-damp which is required to establish the ignition of what may be termed sensitive coal-dust, by means of a naked Davy-lamp flame, and *to promote the propagation of flame* by it, is below that which can, with the means at present employed, be detected in the atmosphere of a mine by most experienced and careful observers. Even with less sensitive dusts (such as those from Seaham) the proportion of gas needed for the *initiation* of such a result is so small that its detection might be doubtful, especially with particular descriptions of fire-damp which do not produce "caps" in the safety lamp.

It may be objected that in such special experiments as those which have been conducted with coal-dust by Mr. Galloway, by the Chesterfield Committee, by the Harton Experimentors, and by myself, the amount of coal-dust which was suspended in air was considerably in excess of that which would exist even in very dusty coal-mine ways, at any time when the explosion may be originated by the combined action of fire-damp and small quantities of dust. But many observations made in the course of these experiments have indicated that even minute quantities of dust may, under favourable conditions, serve as the inciting cause of the ignition of fire-damp mixtures of such a nature that, in the absence of that cause, they would escape ignition. Moreover, the inflaming agency in the experiments which have been described was simply the

naked flame of a safety lamp, whereas the disasters which have been attributed to so-called coal-dust explosions, and which may have been due to the combined action of dust and of fire-damp existing in very small proportions, have, at any rate in several instances, been clearly connected with the firing of shots. It has been demonstrated by the small-scale experiments described in this Report that the sensitiveness to ignition of a mixture of a *small* proportion of fire-damp with air, even in the supposed absence of dust, is very considerably increased if the source of heat or flame to which the mixture is exposed be increased. It has also been demonstrated that the existence of a proportion of fire-damp very much below the smallest specified in the experiments described, in air in which coal-dust is suspended, will suffice to bring about the slow *propagation* of flame by the coal-dust, if the flame from a small cannon charged with *only* 80 *grains* of powder, and representing a blown-out shot upon a very small scale, be projected into it in the gallery used in these experiments. This being the case, there is no doubt that the large body of flame produced in a working by a blown-out shot, or even by a somewhat too heavily charged shot, could produce a similar result in localities where dust is readily and abundantly raised by the firing of a shot, and where very small quantities of fire-damp exist in the air.

ON WILKINSON'S PROCESS FOR THE MANUFACTURE OF ILLUMINATING GAS FROM WOOD.*

By CHARLES A. DOREMUS, M.D., Ph.D.

Though many substances have from time to time been suggested as proper materials from which to procure illuminating gas when subjected to destructive distillation, none seemed to equal coal, either in the quality of gas yielded or in the economy of manufacture. Fats, factory refuse, oil, petroleum have all even now a more or less extended use, and wood is frequently resorted to.

Practical difficulties, however, have always stood in the way of its more general employment. The moisture even in the harder varieties of wood causes a lowering of the temperature of the retorts to such a degree as to largely increase the yield of tar, pyroligneous acid, and gas liquor generally. Besides this, the water, by diminishing the heat, renders the amount of gas produced very small, while the oxygen it contains goes to augment the carbonic acid, the quantity of which may even exceed 25 per cent of the gas. This large amount of carbonic acid necessarily diminishes the illuminating properties of the gas, or as it is commonly expressed, "kills the light." Its removal is therefore requisite, and the cost of purification increased. Except, therefore, in few cases, wood as a source for gas has been practically abandoned.

For several years past it has been customary in some gas works to push the heat in the coal gas retorts, and obtain thereby 3000 or 4000 feet more gas to the ton of coal, but of a very low candle-power, however. This poor gas was then, after purification in the usual way, carburetted either by naphtha vapour or "fixed" naphtha vapour, or by cannel gas. A very excellent quality of gas was thus made, and at a low rate.

The first instance of the use of such a process in this country, we believe, was with the company working under Tessié du Motay's patents, in Buffalo. It was proposed by this company to manufacture water-gas, and enrich it by means of carburetters placed in each house. The danger of the oil (gasoline) was recognised by the insurance companies, and the "*binary*" process of making gas was then inaugurated by Dr. Wilkinson, at that time (1872) chemist for the company. With some alterations this process is in use in all works where gas is enriched.

But coal-gas manufacture was destined to a more radical change than this, in the adoption of the many processes for the production of water-gas subsequently enriched by naphtha. The cost of gas is hereby so greatly reduced that it seemed as if no better method could be suggested. Supplying a gas brilliantly white when burnt, of high gravity, affording great benefit, therefore, to consumers, the projectors of the new enterprises have already reaped, at least in New York, a goodly harvest.

But older companies could not abide such an invasion of their territories without remonstrance, and though, naturally, the competition at first caused fierce disputes, it ended as usual in a coalition.

It was during the heat of battle that the method we are to describe was invented. From an intimate acquaintance with all the methods in use, and especially those of coal- and water-gas, and the advantages and disadvantages of the several processes, Dr. A. W. Wilkinson, chemist of the Mutual Gas Light Company, devised the following plan, which was first tried experimentally at the works, then operated with several benches, and finally adoped on a large scale.

The ordinary clay retort of the gas works, but slightly modified, answers, though in subsequent experiments a somewhat different shaped retort was used, the retort being provided with a fall or "boot."

The essential feature of the process consists in reducing the carbonic acid to carbonic oxide, and at the same time of getting rid of all tar, acids, and waste products. This is accomplished by forcing the gas through a bed of red-hot charcoal. After the first charge of wood has been carbonised, the charcoal, instead of being drawn as with coke, is shoved back in the retort. The gas made from the second charge is therefore obliged to pass through this layer of red-hot coal to reach the stand pipe at the rear of the "through" retort. The heat is pushed to get as large a yield of gas as possible, and the reduction of the carbonic acid correspondingly facilitated.

The water in the wood is also an active agent, since in this superheated state it forms water-gas with the aid of the charcoal. The gas needs but slight purification. Nitrogen in the form of ammonia is virtually absent; little sulphur exists in any form, neither sulphuretted hydrogen nor carbon bisulphide being found, except in traces, while of tar there is not a trace.

To prevent too great an accumulation of charcoal, the retorts are drawn twice a day.

53,832 cubic feet of gas are produced from a cord of wood costing 5·25 dols. per cord of 3300 lbs., as computed from the average of six months.

The quantity of gas alone is thus four times as great as that which can be obtained from coal, costing an equal sum per ton as does wood per cord.

The crude gas has the following composition, as analysed at the works by myself:—

Hydrogen	44·10
Marsh gas	5·40
Carbonic oxide	33·75
Illuminants	none
Carbonic acid	10·50
Nitrogen	6·00
Oxygen	0·25
Ammonia	none
Sulphuretted hydrogen	none
	100·00

It is still customary with the Mutual Company to manufacture a poor quality of coal-gas, which is, along with the wood-gas, afterwards carburetted, and in which form it is termed "commercial" gas, and has a high candle-power. An analysis of the coal-gas, taken from the company's records from an analysis made at the works, shows it to be composed of—

* From the *Journal of the American Chemical Society*, vol. ii. An abstract of this Paper appeared in the Chemical News, vol. xliii., p. 57.

Hydrogen	30·50
Marsh gas	41·00
Carbonic oxide	6·00
Illuminants	2·00
Carbonic acid	3·00
Nitrogen	16·00
Oxygen	1·50
Ammonia	trace
Sulphuretted hydrogen	trace
	100·00

The yield of coal-gas is 14,645 cubic feet per ton of coal, costing 5·00 dols. From this sum we must deduct the price received for coke, tar, and gas liquor.

Prior to admixture with naphtha vapour, the coal- and wood-gases are purified and passed to the storage holder. From this the gas enters an illuminator, so constructed that the naphtha running in is converted into vapour by steam heat, and thoroughly mixed with the gas. From the illuminator, the mixture of gas and vapour passes into superheated retorts to be "fixed." 4·5 gallons of naphtha are used for every thousand feet of "commercial" gas.

As the naphtha is of good quality, no purification of the resulting gas is needed other than passing it through a coke box to remove any liquid naphtha.*

100 volumes of the "commercial" gas of the Mutual Company consists, at present, of 21 volumes of wood-gas, 37·4 volumes of coal-gas, and 41·6 volumes of naphtha gas.

An analysis of the "commercial" gas showed it to contain:—

Hydrogen + Marsh gas	56·75
Carbonic oxide	11·25
Illuminants	15·25
Carbonic acid	1·00
Nitrogen	15·00
Oxygen	0·75
Ammonia	none
Sulphuretted hydrogen	none
	100·00

This analysis shows, also, how closely the composition can be determined by separate analyses of its components, and how, by the speedy method of gas analysis introduced by Dr. Wilkinson, in use not only in the Mutual but other gas works, a complete control of each and every step in the process of manufacture is obtained. As the method has been fully described in the *London Gas Light Journal* for August, 1877, but this brief allusion to it seems required. An addition was made in 1879 to the process, whereby nitrogen could be determ ined and an account published in the *American Gas Light Journal* of that year. The rapidity with which an analysis can be made, and the simplicity of the various steps, give it a decided advantage over other methods.

No new process of manufacture stops with the application of any single scientific discovery; the adoption of wood, therefore, instead of coal, required several changes in the manag ement of the retorts.

The want of coke for firing was the first requirement that made itself felt. Coke might, of course, be purchased from gas works, manufacturing by the older methods, but wood-gas could only thus be manufactured in one or two of the larger cities.

The furnaces were at the Mutual Works, therefore, supplied for a time from the coal benches; but, finally, grates were constructed, to allow the use of "pea" anthracite. The employment of hard coal was only feasible by an increased draught; but to obviate the use of a blower, yet accomplish this result, the following device was adopted.

At the base of the fire pot, an iron tube is inserted, having a blind end. This serves, on being heated red-hot, by the fire, as a superheater for a jet of steam driven in through a central iron pipe, and passing nearly to the blind end of the exterior tube. The steam thus superheated passes next through a small injection pipe into the fire. A draught of air is drawn into the fire by this injector, and the combustion greatly accelerated. The steam also decomposes in presence of the coal, water-gas is formed in abundance, and an intense heat, under absolute control, is attained.

The heat is greatly increased, too, by another ingenious device. Over the benches stretches a long wrought-iron tube, some 2 feet in diameter, and open at each end. The hot gases from the furnaces impinge upon this, heating the contained air. By means of suitable pipes this heated air is drawn down by the steam injectors, and forced into the fires. A hot blast is thus procured. The saving of a dollar per diem for each fire results from the combined use of anthracite and hot blast, over the old system of coke fires.

As regards the relative cost of "poor" coal- or wood-gas, it can be stated at 20 cents per thousand for coal to 9·9 cents per thousand for wood. Not only the four times greater amount of gas yielded enters in this calculation, but the large decrease in expense thereby caused in the less number of hands employed, and also the less cost of purification of wood-gas made by this method. In the calculation of cost of coal-gas the drawbacks in ammonia, tar, &c., have been considered. With wood there are none of these. But the Mutual Gas Light Company contends that it is a gas manufacturer, and therefore does not base its business on side issues.

After this brief outline of the special features of the mode of manufacture, we desire next to call attention to some rather remarkable facts developed in the chemical analysis of the "commercial" product. We have already detailed the analyses of the several constituents of the "commercial" gas, and shown how closely the analysis of the merchantable article agrees with what would be the theoretical result of mixing them in the proportions actually carried out on an enormous scale at the Mutual Works.

In a paper read before the American Association in Boston, August, 1880, Dr. E. G. Love, City Gas Examiner, reports the composition of the various gases sold in New York city.

Besides these, four other analyses of the Mutual gas are given; three made by Dr. Love, and one by Mr. H. C. Bowen, intended to show that there is no material difference in the quality of the gas made by the use of wood from that of coal. These were reported in the *American Gas Light Journal* of October 2, 1880. We insert both tables:—

TABLE I.

Constituents.	Manhattan Co.	Harlem Co.	Metropolitan Co.	N.Y.Mut'l Co.	N.Y. Co.	Municipal Co.
Hydrogen	45·79	46·53	35·41	10·57	27·14	26·25
Marsh gas	39·01	42·38	42·66	41·75	25·35	28·91
Carbonic oxide—	6·31	3·14	9·17	9·53	26·84	27·12
Illuminants	6·38	6·31	7·41	15·41	14·63	15·80
Nitrogen	2·51	0·50	5·35	20·69	2·87	1·92
Carbonic acid	—	1·08	—	1·51	3·02	—
Oxygen	—	0·06	—	0·54	0·15	—
Sulphuretted hydrogen—	—	trace	—	trace	—	—
	100·00	100·00	100·00	100·00	100·00	100·00

Table No. I. differs quite widely in its statements, as published in the *Gas Light Journal*, from the way it was reported in the daily press at the time of the Boston meeting, four of the six analyses being much modified—two, however, being retained in exactly their original shape.

Thus with the Mutual gas the hydrogen, from being 28·87 per cent, falls to 10·57 per cent; marsh gas rises

* Traces of SiH_4 are sometimes observable.

Table II.

	I. July 16,1880.	II. Aug.6,1880.	III. Sept.8,1880.	IV. Nov.27,1877.
Hydrogen	9·65	9·32	12·75	7·53
Marsh gas.. ..	43·55	42·49	39·21	48·63
Carbonic oxide..	8·63	7·64	12·33	6·70
Illuminants ..	15·55	15·45	15·22	14·43
Nitrogen	19·92	22·79	19·36	19·85
Carbonic acid ..	1·48	2·16	0·89	
Oxygen	1·22	0·15	0·24	2·86
Sulphuretted hydrogen—				
	—	—	trace	
	100·00	100·00	100·00	100·00

from 22·95 to 41·75; carbonic oxide falls from 27·19 to 9·53, and nitrogen rises from 3·24 to 20·69 per cent. We are at a loss to explain these variations, especially as the quantity of illuminants is not modified. The gravity also remains as fluctuating between 0·703 and 0·808. The sulphur is 7·28 grs. per 100 cub. ft., and the ammonia 82 grs. per 100 cub. ft., in both analyses.

These discrepancies are, in comparison with the analyses of the commercial products of other companies, particularly noticeable. Yet Dr. Love has taken pains to show, by Table No. II., that analyses of the Mutual gas, ranging over a long interval, demonstrate its composition to be nearly constant. Thus, in comparison with other gases, the carbonic oxide was first stated to be 27 per cent, an amount in excess of that in any water-gas enriched by naphtha, and a fact which does not accord at all with the process of manufacture of the Mutual gas, since we have shown that at least one-third is of a low grade of coal-gas, which would contain about 6 per cent carbonic oxide, and another third wood-gas, with 30 per cent. Were these two gases mixed and distributed in equal proportion, there could only be 18 per cent carbonic oxide, while as they form but 60 per cent of the "commercial" gas, there would at most be but 10 8 per cent of carbonic oxide. The analyses of Tables I. and II. agree to this state of things.

We are surprised also that a coal-gas, such as that sent out by the Manhattan Company, should only contain 1·19 per cent, as in the first report. In Table I. it stands 6·31 per cent. Though in a foot-note Dr. Love states:—"I find considerable variation in composition, especially in those gases enriched by naphtha," we can hardly imagine them to take such curious fluctuations, since the process of manufacture precludes them.

However accurate such a method of analysis as Bunsen's may be, can it not be replaced with advantage by one which, though less correct, allows by the rapidity of execution, duplicate analyses, and thus gives a knowledge of the average composition of a commercial product? From personal experience, we know how tedious an analysis is, and how liable to error from mistakes, not only in the various steps of the method, but the subsequent calculations regarding temperature, pressure, moisture, &c., when carried out as indicated by Bunsen.

In "Watts's Dictionary of Chemistry," 2, 1036, we find the following:—

"The effect of continuing the distillation too long is that gases of a very feeble illuminating power are evolved together with nitrogen, which, when once mingled with the combustible gas, cannot be removed by any known method, and must seriously impair its illuminating power." We have shown, not only by our own analysis, but by Dr. Love's, that the Mutual "commercial" gas contains about 15 to 20 per cent nitrogen. That this is not present as air is seen from the only trivial quantity of oxygen. The nitrogen must have gained access in great measure from the fires around the retorts, as well as in small quantity from the leakage of air, the oxygen in the latter case being consumed in the retorts.

By an adjustment of the exhaust, the company attempts to keep the proportion of nitrogen in the "commercial" gas at 15 per cent, and there is not much variation from this figure.

No other New York company furnishes street gas with so high a percentage of a neutral gas.

According to Dr. Love's analysis, and his statement of the various candle-powers, as given in Table III., the Mutual ranks as containing ten times as much nitrogen as the Municipal: yet, both having the same amount of illuminants, it is only three candle-power lower. From photometric measurements at the College of the City of New York, the Mutual gas was found, on November 27th, to stand 25·5 candle-power, and had 17 per cent nitrogen.

According to these facts, the old impression that the presence of nitrogen is destructive to the light-giving properties of street gas, must fall, or whatever holds good for coal-gas is not found to follow in coal-gas enriched by naphtha. Never before has gas been furnished in New York of such brilliancy as at present. Each company charges 2·25 dols. per thousand. Let us suppose the Mutual Company delivers 3,000,000 cubic feet per diem; 15 per cent of this, or 450,000 cubic feet, is nitrogen, which, at 2·25 dols. per 1000, gives 1023·50 dols. per diem clear profit. This percentage of nitrogen does not seem to cause any smoking of the flame; the company receives no more complaints on this score than do others. The consumption of naphtha is always about 45 gallons per 1000 cubic feet of "commercial" gas, a quantity below that required in other gas works.

We specially desire, therefore, in connection with the description of the wood-gas process, to point out these peculiarities regarding nitrogen, trusting new experimentation will develop more clearly the reasons for these phenomena.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, from May 20th to June 30th, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

July 4th, 1881.

Sir,—Our present report has reference to the quality of the water supplied to the Metropolis, from the 20th of May to the 30th of June inclusive, and relates to the examination during this period of 245 samples which have as usual been collected by a man in our employ, at times and places determined by us. In future, our reports wil

Table III.

Company.	Hydrogen.	Marsh Gas.	Carbonic Oxide.	Total Non-Illuminants.	Illuminants.	Nitrogen.	Carbonic Acid.	Oxygen.	Candle-Power.
Manhattan ..	45·79	39·01	6·31	91·11	6·38	2·51	—	—	19·76
Harlem	46·53	42·38	43·14	92·05	6·31	0·50	1·08	0·06	17·59
Metropolitan ..	35·41	42·66	9·17	87·24	7·41	5·35	—	—	20·33
N.Y. Mutual ..	10·57	41·75	9·53	61·85	15·41	20·69	1·51	0·54	26·53
New York ..	27·14	25·35	26·84	79·33	14·63	2·87	3·02	0·15	24·35
Municipal ..	26·25	28·91	27·12	82·28	15·80	1·92	—	—	29·68

relate to the analyses of samples obtained from the 1st to the end of each month.

In 10 only of the 245 samples examined were we able to detect by examining the water in large bulk with the naked eye the minutest trace of matter in suspension.

In Table I. we have recorded the analyses in detail of samples, one taken daily between May 20th and June 30th. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of daily samples of the water as determined by the colour-meter we have described in a previous report. Practically the waters differ very little in their appearance (even when examined in large bulk) from distilled water. If complaints of inferior colour and of turbidity arise, it is manifest to us that the contamination and impurities complained of, are to be traced to the condition of the receptacles, rather than to the want of care on the part of the Water Companies in providing a proper supply.

For several months we have been experimenting on a method whereby the slight amount of clayey matter occasionally present in the waters could be determined with a nearer approach to quantitative accuracy than is possible by classifying the samples under the headings "clear," "very slightly turbid," slightly turbid," and "turbid," and we hope to make known our results in this direction in our next month's report.

Of the 35 samples supplied by the New River Company, the whole were found to be clear, bright, and efficiently filtered.

Of the 35 samples from the mains of the East London Company, 2 were noted as "very slightly turbid." The remainder were bright, clear, and well filtered.

Of the 35 samples from the mains of the Chelsea Water Company, 2 were noted as "very slightly turbid." The remaining 33 samples were bright, clear, and well filtered.

Of the 35 samples from the mains of the West Middlesex Company, 1 was found "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 35 samples from the mains of the Lambeth Water Company, 4 were found to be "very slightly turbid." The remainder were clear, bright, and well filtered.

Of the 35 samples from the mains of the Grand Junction Company, the whole were clear, bright, and well filtered.

Of the 35 samples from the mains of the Southwark and Vauxhall Company, excepting one, the whole were clear, bright, and efficiently filtered.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen in the whole of the samples collected.

Judged by our daily examinations, the water supplied to London is, in our opinion, whether considered as to its efficient filtration or as to its proper aëration, or as to its purity and wholesomeness, unimpeachable. The result of our six months' work, and the examination during this period of 1,127 samples, enable us to state that as an excellent drinking supply it leaves nothing to be desired.

We remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

The Part and the Origin of Certain Microzymas.—M. Béchamp.—The author examines the microzymas of swamps, of different kinds of earth, and of the street-dust of Montpellier, &c. He holds that the microzymas found in chalk, rocks, soils, &c., have no other origin than the microzymas which form an integral part of every living organism, the physiological function of which is the total destruction of the organism after its death.—*Comptes Rendus.*

OBITUARY.

DEATH OF PROF. SAINTE-CLAIRE DEVILLE.

SCIENCE has recently sustained a heavy loss in the death of one who for the past thirty years has had few equals and no superior in the fields of mineral chemistry and of inorganic analysis.

Etienne Henri Sainte-Claire Deville was born March 18, 1818, in the island of St. Thomas, in the West Indies. At an early age he manifested an ardent passion for the study of chemistry, which at that time found in France so many of its most distinguished professors. His abilities were manifested so early that at the age of 26 he was commissioned to organise the Faculty of Science, newly created in Franche Comté, and to preside over it as its dean. Here he undertook the analysis of the waters of the Doubs and of the springs around the town of Besançon, and greatly improved the methods then known for water analysis. Shortly after, he succeeded in preparing nitric anhydride, which previously had been attempted in vain. Toluol was another of his discoveries. In his 33rd year he succeeded Balard in the chemical chair at the Ecole Normale Supérieure, at Paris. Here, his emoluments only reached the modest sum of 3000 francs, chemistry in France, as well as in England, being supposed to be its own reward. His next researches related to the properties and the industrial preparation of aluminium—discoveries which attracted public attention throughout the world. He then turned his attention with signal success to the metallurgy of platinum, and its separation from its associated metals. His investigations on boron and silicon are also well worthy notice, and his production of sodium at a cheap price has placed a powerful reagent in the hands of chemists, and has led the way to valuable results both in the laboratory and in industrial establishments. His highest achievement, from a strictly scientific point of view, was the establishment of the laws of dissociation. Previously, decomposition was regarded as a simple phenomenon, effected and completed, in the case of every substance, at a fixed temperature. Deville showed that in some cases it is effected within certain limits of temperature, being arrested at a given heat by the equilibrium established between the decomposing body and its products of decomposition.

A most admirable characteristic of the deceased *savant* was his strict accuracy—an attribute all the more deserving of honour in a man of his ardent and impetuous temperament. Among his pupils may be counted not a few of the most meritorious among the younger French chemists, such as Debray, Troost, Hautefeuille, Grandeau, Gernez, and others.

M. Deville died on July 1st, at Boulogne-sur-Seine, and was buried on the 5th. His old friend, M. Pasteur, pronounced an eloquent and impressive *éloge* at the funeral. All honour to his memory, and may his experimental accuracy, which M. Pasteur aptly calls the "probity of the chemist," find abundant imitators.

Detection of Nitro-benzol in Oil of Bitter Almonds.—Enrico Pegna.—The oil is mixed with a little alcohol, a solution of pure potash, and a few drops of ferric chloride. The mixture is allowed to stand for some hours, shaken, and distilled, avoiding with great care bumping or spitting, and the direct action of the flame upon any part of the oil. A portion of the distillate, dehydrated, is heated in a test-tube with a few fragments of pure potash. If the oil was pure the mixture remains colourless. If nitro-benzol was present there is produced a dark colouration from the formation of azo-oxy-benzol, and as a little aniline is also formed, a few drops of solution of chloride of lime added to the cold mixture produce a violet colouration.—*Zeitschrift für Analytische Chemie.*

CORRESPONDENCE.

REMARKS ON MR. TATLOCK'S CHALLENGE.

To the Editor of the Chemical News.

Sir,—A strange fascination has again led Mr. Tatlock to that corner of the field of chemical analysis devoted to the estimation of potash by platinum, wherein he stumbled some fourteen years ago.

Stranger still, as showing how a man may be, as it were "possessed" by a subject, is his elaborate challenge of May 1, 1880—"To the Manufacturers of Potash Salts in Germany," addressed, in duplicate, to them, and stipulating, among other somewhat vague conditions, that "Prof. Fresenius, of Wiesbaden, is to make experiments on myprocess," and to do so "in my presence, and in that of a representative chosen by the German manufacturers;" and that, "in the event of the mean result coming out above 99·50 per cent." What can be intended by this "ninety nine and one-half per cent?" However, should this result, be it what it may, "come out above 99½ per cent, the manufacturers will pay my travelling and hotel expenses from and back to Glasgow," there is a praiseworthy exactness here, "and that whatever the results may be, the manufacturers will pay Fresenius's fees."

The strangest incident in this odd affair is, it seems to us, the simplicity of the challenger, who persuading himself that his challenge would be eagerly caught at by a number of manufacturers, instead of being pooh-poohed, or utterly neglected by these gentlemen, has led him to say in a fractious and aggrieved tone that, "up to the present moment this challenge, for obvious reasons," fie! fie! Mr. Tatlock, "remains unaccepted." However simple-minded a man may be, it is well nigh incredible that he should also be so destitute of humour as to be blind to the absurdities on the one hand, and the serious imputation on the other, involved in a challenge, of which he is so enamoured, as to say "which every unbiassed person will admit is fairness itself;" a judgment we will not dispute, although we find it difficult to understand why the challenger did not discern the impracticable nature of his proposal, which demands negotiation and agreement between all the "manufacturers of potash salts in Germany," be they five or fifty, with their various tempers, interests, and views, to determine the just and proper *quota* each should pay, in a given event, towards the discharge of Mr. Tatlock's fare and tavern bills to Wiesbaden and back to Glasgow. It is further provided that these associated manufacturers pay certain fees to Dr. Fresenius, and also that they appoint a representative to watch the "experiments made by Dr. Fresenius or his assistant in his laboratory at Wiesbaden, in my presence." The fun of the thing, perhaps, reaches its climax here. The challenger quietly assumes Fresenius's consent to this preposterous suggestion, and leaves us with the picture on our minds of Dr. Fresenius experimenting away at Wiesbaden, watched by detective Tatlock on the one side, and detective Kalimacher on the other, to see fair-play. We have said the fun culminates here, and maybe it does, yet we do not know if the proposal that these manufacturers should band themselves together and organise an association so that each should pay his proper *quota* of Mr. Tatlock's travelling expenses, appoint a representative to watch Dr. Fresenius, and gain his assent to this programme; in order, that in a given event, Mr. Tatlock shall add a certain unspecified amount, called in the challenge "the difference," and which, so far as we can find, amounts, at the utmost, to 0·50 per cent of muriate of potash, does not transcend the single incident in absurdity:—*Montes parturient et nascitur ridiculus mus.*

There is a serious view, however, of this subject, which justifies our statement that Mr. Tatlock was "possessed," when issuing this challenge; *i.e.*, he must have been so carried away by his belief in its overwhelming importance, as to blind him to the utter want of courtesy, to speak mildly, of which he has been guilty. Else, how could he have conceived, much more how could he have given birth, to the unworthy thought, that in order to obtain the truth from Dr. Fresenius as to the result of any experiments made by him, the challenger should specify "that these experiments be made by Prof. Fresenius or his assistants, in his laboratory at Wiesbaden, *in my presence*, and in that of a representative chosen by the German manufacturers." The italics are ours. Of one thing we rest assured, that when Mr. Tatlock perceives the only obvious meaning of this proviso, he will publicly offer the most ample apology to one so deservedly honoured as is Dr. Fresenius, who, whilst unlikely to notice this untoward remark, should be assured that the imputation conveyed is distinctly repudiated by English chemists.

Mr. Tatlock is so much aggrieved by the ignoring of his challenge that he quarrels with and sneers at every one who crosses his path in this matter. Thus Drs. Zuckschwerdt and West, who have ventured, and who are quite within their right in so venturing, to examine and criticise his process, are always spoken of by him in an unpleasant tone, quite unprovoked by them, unless adverse criticism can be justly regarded a provocation. Of these gentlemen, who appear to us to be capable analysts and fair and just critics, he tells us "they make experiments privately upon my method, and tell us what results they got in this way when nobody was present to verify them, and affect to be simple enough to suppose that we shall credit their results," and much more in the same unwarrantable style, which almost induces us to repent of the favourable interpretation we gave to the same idea when applied to Dr. Fresenius. Mr. Tatlock always speaks of these gentlemen as "the two doctors," with a little "d," as if the Doctorate of a German University, achieved by a German, were not pretty certain to be an honourable title conferred by a recognised Authority, forgetful all the while that he had bedecked himself with a title derived from the "*Limited Liability Act*"!

We have read the memoir of Drs. Zuckschwerdt and West (Chemical News, vol. xliii., p. 251), which is both clear and inoffensive; nor do we think the method of analysis described by them open to any objection beyond the "balanced filter." We venture to doubt whether the solution of "0·3250 grm. of the double chloride" they speak of, is due to the chloride of platinum itself, regarding it as owing to the acid water in which the platinum salt is dissolved, which constitutes an obvious and constant defect in Mr. Tatlock's method—a method which they have permitted themselves to say "should be completely rejected." These "two doctors" have not had the fear of Mr. Tatlock before their eyes, a hardened state in which we also find ourselves, and thus we requested our principal assistant, Mr. Beverley, to examine Mr. Tatlock's present method and report to us. He states that the double chloride of platinum and potash is almost one hundred times more soluble in Mr. Tatlock's 7 per cent of platinum solution than in alcohol of 95 per cent. That his solution of "muriates," is nearly three and a half times stronger than that we are accustomed to employ, which greatly augments his liability to error. That his great excess of platinum is not only unnecessary but injurious. That in other respects his method is ours, and that Mr. Tatlock's process has been recently criticised by Drs. Zuckschwerdt and West, Mr. Tatlock's "two doctors," who published nearly 40 determinations of potassium by his and Fresenius's method, which latter is almost identical with our own, and show that Mr. Tatlock's is liable to a loss of 0·30 per cent. After detailing his mode by preparing pure KCl, Mr. Beverley subjoins his results from six analyses of 10 grains of salt = 8 grs. of KCl and 2 grs. NaCl. (See table next page.)

These results are more in Mr. Tatlock's favour than are the German ones, but plainly point to the defect inherent in his method to which he still fondly clings, the use of

Tatlock's Method.

	Pt salt	=	p.c. KCl agst. 80 p.c. used.
A.	26·19	=	79·898
B.	26·20	=	79·928
C.	26·17	=	79·837

A shows a loss of 0·102 per cent; B, of 0·072 per cent; C, of 0·163 per cent.

Teschemacher and Smith's Method.

	Pt salt	=	p.c. KCl agst. 80 p.c. used.
D.	26·22	=	79·989
E.	26·22	=	79·989
F.	26·19	=	79 898

D and E are each 0·011 per cent too low; and F, 0·102 per cent.

an aqueous solution of platinic chloride, of which we have before spoken. When he discards this, and consigns it to the limbo of forgetfulness, wherein repose his old coadjutor, Mr. Chalmers, and the former "key-stone of their entire process" "perfectly pure platinum," and further uses a far more dilute solution of his sample of German muriate, he will employ a method with which he is perfectly well acquainted, but which, as other of our readers may be pardonably ignorant, may be found in the CHEMICAL NEWS, vol. xvii., p. 244.

We may here, perhaps, be allowed to say the "key-stone" of our process, the obtaining the potassio-platinic chloride in *brilliant orange coloured crystals* which permits of the most rapid and complete washing, is the discovery of the late Mr. Teschemacher the younger. An improvement, so great on the former process, that we regard the determination of potash and also of ammonia by platinum, as being among the most perfect of analytical processes when these double chlorides are obtained by gentle evaporation of the acid aqueous solutions in brilliant clusters of crystals.

As respects German makers and English buyers of muriate of potash, we take leave to say that if these gentlemen can transact their business, selling and buying within a quarter per cent of the actual value, they will be contented. Whilst as to the challenger, we would hope the next time Mr. Tatlock appears in print, respecting the estimation of potash by platinum, he will bear in mind that as both his manifestations have been signalised by error, a more modest demeanour and a greater courteousness in tone, would befit him better than the assumption and imputations which characterise his challenge and his communication of the 17th ult. to the CHEMICAL NEWS, vol. xliii., p. 273.—We are, &c.,

E. F. TESCHEMACHER and J. DENHAM SMITH.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 23, June 6, 1881.

Researches on Nitrogen Sulphide.—MM. Berthelot and Vieille.—This compound is formed with absorption of heat like all the binary compounds of nitrogen, except ammonia. Hence it can only be obtained by indirect methods.

New Analyses of Jade and certain Sodiferous Rocks.—A. Damour.—The author gives analyses of certain Asiatic and Mexican specimens, and of certain European minerals, which do not differ widely from the former in composition. He thinks it probable that a deposit of jade will be found in the Alps.

Study on Electricity as Manifested on Board Modern Ships, with Remarks Concerning the Method of Soldering in Complex Electric Circuits, and the Principle of an Electric Hygrometer and a Fire Alarm.—A. Ledieu.—The author shows that when the immersed portions of an iron-clad are sheathed with wood, above which is a copper coating, fixed to the iron by metallic connections, we have a complex battery, the nature and the functions of which he has studied. From his results there "may be deduced the principle of an electric hygrometer, especially useful for measuring dew," which, however, he does not describe. The fire alarm consists of a piece of wood, connected to the wires of a constant battery by means of strong copper screws sunk up to the head. This piece of wood is kept slightly moist by means of a coating of spongey material kept in communication with a receptacle for water. The instrument is placed in the interior of the compartment (powder magazine, or coal room), the temperature of which is to be observed. The battery is placed outside, and a very sensitive galvanometer is introduced into its circuit. This galvanometer indicates by the movements of its needle the variations in the dryness of the wood. The needle may be arranged to set in action an electric bell on reaching zero.

The Part Played by Phosphoric Acid in Volcanic Soils.—P. de Gasparin.—A superabundance of phosphoric acid counts for nothing in the phenomena of vegetation. An exceedingly fruitful garden between Catania and Nicolosi contains merely two parts of phosphoric acid per thousand. The soils of the plain of the Vistre at Nimes, of St. Contest at Caen, and of Castro-Giovanni, in Sicily, do not contain more than one-thousandth, whilst the alluvial soils of l'Ardèche and of the Rhone fall still lower.

The Liquid and the Gaseous State.—J. B. Hannay.—From an English source.

Sodium and Barium Cyanides.—M. Joannis.—A thermo-chemical study.

Compounds of Lead Iodide with the Alkaline Iodides.—A. Ditte.—The decomposition of lead potassium iodide by water is effected according to ordinary laws, that is, at every temperature the solution which floats over the double salt without decomposing it must contain a minimum and well-defined quantity of alkaline iodide.

Non-existence of Microzyma cretæ.—MM. Chamberland and Roux.—The authors consider that the experiments of M. Béchamp have not been conducted with the requisite precautions.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. ix., No. 9.

The Source of the Atmospheric Carbonic Acid.—Dr. M. S. Meunier.—The author maintains that the interior of the earth contains large beds of carboniferous cast-iron, which, coming in contact with water at high temperatures, yields hydrocarbons. These, on their subsequent combustion, give rise to the carbonic acid exhaled from the earth.

Fluctuations in the Proportion of Carbonic Acid in Underground Waters.—Dr. M. Popper.—The proportion of carbonic acid varies at different depths of one and the same well, decreasing upwards. There is no relation between the amount of carbonic acid in the water and its level, but its percentage increases with a fall of the barometer. The variations in the proportions of chlorine and carbonic acid do not correspond.

Researches on the Drainage Water of Reclaimed Moors.—Dr. R. Schiller.—The waters were found very rich in soluble matter.

Researches on the Application of Manure to Vineyards.—Drs. P. Wagner and H. Prinz.—The authors recommend that the present practice should be inverted, and

that farm-yard manure should be chiefly applied to arable lands, and chemical manures to the vineyards.

Behaviour of Different Phosphates with Carbonated Waters, both when alone and when Distributed in Different Soils.—H. Albert and R. Wagner.—The author concludes that on barren calcareous sands phosphoric acid is more efficacious in the state of bibasic calcium phosphate and of aluminium and iron phosphates than when soluble. He infers that the phosphorites from the Lahn, with a high percentage of iron and aluminium phosphate, are better than superphosphates made from minerals free from alumina and iron.

Manurial Experiments on Certain Root-Crops.—J. Godefroy and A. Doudonz.—Not suitable for abstraction.

Is Glycerin a Nutritive Matter?—Dr. Munk, Dr. Lewin, and N. Tschirwinsky.—The authors decide that glycerin has little or no nutritive value.

Re-absorption of Fats and Fatty Acids in the Intestine and their Utilisation in the Organism.—A. Will and Dr. Munk.—Not suitable for abridgment.

Comparative Experiments on the Value of Linseed Cake and a Mixture of Indian Meal and Cotton-seed Cake for Oxen.—From an English source.

Experiments on the Consumption and Purification of Lupins.—MM. Puttkammer, Glaser, Schlæger, and Schmidt.—Not suitable for abstraction.

Composition of Oats.—L. Grandeau and A. Leclerc.—The mean composition of oats, as ascertained from 120 analyses is:—

Moisture	12·01
Nitrogenous bodies	9 80
Non-nitrogenous extractive	59·09
Fat	4·58
Cellulose	11·20
Ash	3·32

Chemical Composition of Linseed.—A. Ladureau.—The total percentage of ash, the proportion of its soluble and insoluble constituents, and the residue insoluble in acids are nearly constant. The phosphoric acid in the ash ranges from 40 to 15 per cent.

Occurrence of Ammonia in Plants, Muscular Juice, and in Yeast.—H. Pellet.—In plants ammonia is widely distributed. In the juice of 100 grms. beef the author found 0·15 ammonia, and in yeast an average percentage of 0·059.

The Alleged Conversion of Albumen into Fat during the Ripening of Cheese.—Dr. O. Kellner and N. Sieber.—The authors do not admit this supposed conversion. The absolute proportion of fat in cheese decreases slightly during ripening.

A Cheap and Rapid Process of Obtaining Sugar from Treacle.—Dr. Jünemann.—The author obtains a saccharate of lime by treatment with caustic lime, water, and steam, at 8 atmospheres; frees the compound thus obtained from mother-liquor by pressure and by washing at a high tension, and when brought to 99·3 decomposes it. Dr. Scheibler doubts the value of the process, as the temperature employed (172°) destroys sugar, especially in presence of lime.

Disease of Apple Trees due to Alcoholic Fermentation in their Roots.—Ph. van Tieghem.—The presence of alcohol was proved beyond doubt. The author ascribes the cause to a deficiency of oxygen, due to wet weather, and recommends drainage.

Diastase and the Influence of Foreign Bodies on its Efficacy.—J. Kjeldahl.—Small proportions of acid augment the action of diastase, but a slight increase proves injurious. The smallest proportions of alcohol check the effects of the diastase. The action of alcohol is injurious.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bright-Plating.—For some time past I have been endeavouring to form a solution technically termed "bright," composed of bisulphite of soda and hyposulphite of soda. It is known as the French system by Roseleur, now used practically by electro platers in place of bisulphide of carbon. I have also tried the addition of ammonia to the solution, but have failed to get a deposit of "bright" metal. My object is bright-plating by the above preparations of soda.—W. H. S.

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NOTICE TO CONTRIBUTORS OF MEMOIRS.—Authors are reminded that, under an arrangement dating from 1871, the acceptance of Memoirs, and the days on which they are to be read, are now, as far as possible, determined by Organising Committees for the several Sections *before the beginning of the Meeting*. It has therefore become necessary, in order to give an opportunity to the Committees of doing justice to the several Communications, that each Author should prepare beforehand an abstract of his Memoir, of a length suitable for insertion in the published Transactions of the Association, and the Council request that he will send it, together with the original Memoir, by book-post, on or before August 1, addressed thus:—"General Secretaries, British Association, 22, Albemarle Street, London, W. For Section . . . . ." Authors who comply with this request, and whose papers are accepted, will be furnished *before* the Meeting with printed copies of their Reports or Abstracts. If it should be inconvenient to the Author that his Paper should be read on any particular days, he is requested to send information thereof to the SECRETARIES in a separate note.

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1130.

COLLIERY EXPLOSIONS.*

By F. A. ABEL, C.B., F.R.S., President of the Institute of Chemistry, Chemist to the War Department, &c.

(Concluded from p. 31.)

III.

A series of experiments, variously modified, has been instituted with the most sensitive of the samples of dust from Seaham Colliery, and also with the specially inflammable dusts from Leycett Colliery, for the purpose of ascertaining whether evidence could be obtained of a tendency of coal-dust, when suspended in the air, *in the complete absence of fire-damp*, to become ignited and to convey or propagate flame.

It was observed in the first instance that the travelling of a dust-cloud past the naked flame of a safety lamp merely produced a fringe of scintillations round the flame; but when the latter was replaced by a large flame produced by a jet of the pit-gas, a very decided elongation of the flame took place when the cloud of dust reached it, travelling at a velocity of 300 feet per minute, and a small flare was occasionally produced. The lengthening of the flame was increased by increasing the velocity of the air-current, so that its length eventually was three or four times that of the gas-flame in the absence of the dust (Seaham, K).

With a view of exposing coal-dust suspended in air to a flash of flame of considerable volume, and of thus producing conditions similar to those which might exist if an explosion of fire-damp occurred in contiguity with coal-dust suspended in air free from fire-damp, heaps of loose gun-cotton (300 grains) were placed on the floor of the gallery, and fired by electricity, the length to which the flash of flame extended, both with and against the current, being noted in the first instance when no dust was present, and afterwards when dust clouds were travelling at the time at different velocities.

At the lower velocities (200 and 300 feet per minute) the volume of flame was decidedly increased when the dust-cloud was passing, and the increase became more marked when the dust was travelling at a higher velocity (1000 feet per minute), it being then specially noticed (what was observed also, though to a less marked extent, at low velocities) that the flame extended considerably further in the direction of the current, but less far *against* the current, when dust was passing, than when the gun-cotton was fired in the absence of dust. Thus in some parallel experiments when the gun-cotton heap was fired at a distance of 20 feet from the far end of the gallery, the following results were obtained :—

Air current 1000 ft. per min.	Length of Flame.				
Gallery free from dust	9 ft.	with current	6 ft.	against	
,, ,, ,,	9	,,	,,	6	,,
Seaham (K) dust passing	14	,,	,,	3 ft. 6 in.	,,
,, ,, ,,	14	,,	,,	4	,,
Gallery free from dust	10	,,	,,	5	,,
Leycett dust passing	15	,,	,,	3	,,

It will be observed from these numbers that the *total* length of the flame produced was not greatly increased, but that the dust showed a tendency to carry the flame in the direction of the current, and appeared to check the flame where it met the current.

Experiments similar to these with gun-cotton were made with freely exposed charges (400 grains) of blasting-powder and sporting powder, placed in heaps upon the floor of the gallery and fired electrically. The most readily inflammable of the Seaham coal-dusts, and the still more inflammable dust from Leycett Colliery, were passed through the gallery at a velocity of 100 feet per minute, and the total distance to which the flame extended on firing the powder-charge while dust was travelling, was not found to be greater than when the powder-charges were exploded under the same conditions, but in the absence of dust, as shown by the following examples :—

Air current 100 feet per minute.	Powder Charge.	Length of Flame. With current.	Against.
	Blasting.		
Gallery free from dust	400 grains.	7 feet	5 feet
,, ,, ,,	,,	7	5
Leycett dust passing	,,	6 ft. 6 ins.	2
Seaham (X) ,,	,,	6 ,, 6	1 ft. 6 ins.

When the dust was passed at a velocity of 500 feet per minute there were decided indications that the coal-dust increased the total distance to which the flame extended.

Air current 500 feet per minute.	Powder Charge.	Length of Flame. With current.	Against.
	Sporting.		
Box free from dust	400 grains	8 feet	3 feet
Leycett dust passing	,,	8	6

(Many sparks extended beyond the forward flame.)

	Blasting.		
Box free from dust	400 grains	5 feet	2 feet
Leycett dust passing	,,	7	3
,, ,, ,,	,,	7	2 ft. 6 ins.

At a velocity of 1000 feet per minute the increase of the flame by the dust cloud was much more marked when blasting powder was used, but not so with sporting powder, a difference which may perhaps be ascribable to the considerably longer duration of the flame produced by an explosion of the comparatively slow-burning mining powder. The actual heat developed would be greater with the sporting than with the mining powder.

The results obtained at this velocity with the two descriptions of powder are shown in Table III.

Numerous experiments, varied in several particulars, have been made with Seaham and other dusts by firing small charges of powder from either while dust was being carried through the gallery by air currents of different velocities, or with dust deposited upon the floor and sides of the gallery. In the latter description of experiments, two shots were sometimes fired in succession, and in different directions (with and against the air-current), so that dust raised by the concussion and rush of gas from the first shot might be exposed to the flame of the second. In all instances with different samples of dust from Seaham, Leycett, and Garswood Hall Collieries, in air-currents travelling at velocities 100, 200, and 300 feet per minute, the results were negative. At a velocity of 1000 feet per minute, a slight but decided indication was obtained in several experiments that dust particles were inflamed by those shots which were fired in the direction of the air-current. In these instances the volume of flame produced on firing the shot was certainly greater than when no dust was suspended in the air, but the duration of the flash was but slightly if at all prolonged. On one single occasion a long reddish flame was produced when a shot was fired, which travelled to the forward end of the gallery. Some fire-damp had been passed into the latter just previously, and it was evident that, although the apparatus had subsequently been ventilated, the exceptional result was due to the presence of some, though certainly a very

* Report on the Results of Experiments made, with Samples of Dust collected at Seaham Colliery, in compliance with the request of the Secretary of State for the Home Department, conveyed by letter dated November 4th, 1880.

TABLE III.

Air Current 1000 feet per minute.	Powder Charge.	Distance from Drum.	Distance from End of Gallery.	Length of Flame.
	Sporting powder.			
Box free from dust	400 grains	15 feet	13 feet	9 feet with the current, 4 feet against current
Leycett dust passing.. ..	,,	,,	,,	9 ,, ,, 4 ,, ,,
Box free from dust	,,	10 feet	18 feet	10 ,, ,, 2 ,, 6 ins. ,,
Leycett dust passed.. ..	,,	,,	,,	10 ,, ,, 2 ,, 6 ins. ,,
Box free from dust	,,	5 feet	23 feet	18 ,, ,, 5 ,, ,,
Leycett dust passed	,,	,,	,,	22 ,, ,, 3 ,, ,,
	Blasting powder.			
Box free from dust	400 grains	10 feet	18 feet	7 ,, ,, 4 ,, ,,
Leycett dust passing.. ..	,,	,,	,,	To end of gallery 4 ,,
Box free from dust	,,	5 feet	23 feet	10 feet with the current, 4 ,, against current
Leycett dust passing.. ..	,,	,,	,,	22 ,, ,, 3 ,, ,,
Box free from dust	200 grains	,,	,,	7 ,, ,, 1 foot ,,
Leycett dust passing.. ..	,,	,,	,,	13 ,, ,, 1 ,, 6 ins. ,,

small, quantity of fire-damp, for when the experiment was very carefully repeated, all conditions, except the possible presence of gas, being identical with those previously existing, the only effect observed was a slight increase in the volume of the flash of flame produced by the shot, which has been described.

Some experiments made with these cannon in air-currents containing small quantities of fire-damp, with or without the presence of suspended coal-dust, afforded instructive corroboration of the results described in the second part of this report. Two or three illustrations will suffice. Cannon were fired in a mixture of air and 2·5 per cent of fire-damp passing at velocities of 100 and 200 feet per minute, and in an atmosphere containing 3·75 per cent, travelling with a velocity of 300 feet per minute, without any effect. With only 1·75 per cent of gas (at 100 feet velocity), coal-dust being abundantly suspended in the air, the portion of the gallery immediately in front of the flash produced by the shot was filled with flame, which did not, however, travel further; corresponding results were obtained by firing the shot against and with the current. With a slight increase in the proportion of gas (2 per cent and 2·25 per cent), the dust being freely passed, the gas- and dust-mixture was inflamed throughout, with explosive effect. On one occasion air containing 2 per cent of gas was passed at a velocity of 100 feet per second through the gallery in which there was only a very small quantity of coal-dust deposited upon the bottom and sides; when a shot was fired in the direction of the current a reddish flame was produced which extended to a distance of four feet, and which rolled along the floor of the gallery a further distance of three feet. This result illustrated the influence of a few dust-particles in promoting the ignition and propagation of flame by a gas-mixture which otherwise would not have inflamed; an effect which corresponds to the influence exerted by an exceedingly small proportion of gas in determining the ignition and propagation of flame to some distance by a cloud of coal-dust, as demonstrated by an experiment just now described.

Summary.

The principal facts which appear to have been more or less conclusively demonstrated by the results obtained in the experiments with dust from Seaham Colliery and other sources, which form the subject of this report, may be summarised as follows:—

1. Several of the samples of dust collected in Seaham Colliery in November, 1880, exhibited signs of having been affected by heat; those indications were very slight in some instances, and considerable in only three samples, viz., in Q (scraped off stones on return side of Polka doors), R (from No. 1 engine plane at long turn), and T (from floor of No. 1 travelling road).

2. The two samples taken from the floor and off timbers at the curve in the stone drift (in proximity to where the shot was fired at the time of the explosion), as also the sample from near Maudlin engine, exhibited no signs of having been affected by heat.

3. The samples of Seaham dust exhibited considerable differences in regard to richness in coal, fineness and uniformity in this respect, density, &c.; the proportion of coal ranged from about 96 to below 54 per cent in the dry sifted samples.

4. The chemical and microscopical examination did not furnish any data to lead to conclusions as to the extent to which the dust may have taken part in the production or augmentation, and transmission, of the explosion at Seaham Colliery.

5. But there was evidence of the existence of partially burnt dust at a number of points very distant from each other, and in different directions in the colliery.

6. The several samples of dust differed from each other considerably in sensitiveness, *i.e.*, in the readiness with which they promoted the ignition of a mixture of air and fire-damp in such proportions that it was not inflammable *per se* when brought into contact with the flame of a lamp, or, in regard to the proportion of fire-damp required by the several samples to impart explosive properties to them, when suspended in air.

7. The most sensitive of the Seaham dusts were found to be those which were the richest in coal, and those which also contained the highest proportions of very fine dust.

8. Comparing the samples of Seaham dust with dusts obtained from other collieries where disastrous explosions have recently occurred, it was found that the most sensitive of the former was somewhat less sensitive than samples of dust obtained from Leycett Colliery (Fair Lady Pit), which ranked highest in this respect among all the samples experimented with. The Leycett dusts corresponded closely in chemical character and specific gravity to the purest Seaham coal-dust; their somewhat greater sensitiveness was perhaps ascribable to their remaining more uniformly suspended in air-currents, but possibly also to physical peculiarities.

9. One of the Seaham dusts which ranked high (third) in order of sensitiveness contained the lowest proportion of coal of all the samples, and consisted of non-combustible matter to the extent of nearly half its weight.

10. Special experiments, which were instituted in consequence of the behaviour of this sample, demonstrated that some perfectly non-combustible powders, which are also not susceptible of any chemical change when exposed to the action of flame, are very little inferior to the most inflammable or sensitive of the Seaham dust samples in their power to bring about the ignition of an otherwise uninflammable mixture of fire-damp and air.

11. Mixtures of fire-damp and air, in proportions bordering on those which will ignite on the approach of flame, are inflamed instantaneously if they contain in suspension only few particles of such non-combustible dusts, or of the Seaham or other dusts from coal-pits.

12. This effect appears ascribable, at any rate in part, to the fact that these dust particles, when they pass through a lamp-flame, immediately become incandescent and thereby localise and intensify the heat at those points, and thus bring about the ignition of the mixture of air and fire-damp by which they are surrounded. But some phenomena observed in the course of the experiments with non-combustible powders favour the belief that finely-divided solids of particular descriptions may exert another quite distinct kind of action when heated in fire-damp mixtures, which may at least contribute importantly in determining the ignition of gas-mixtures which are not susceptible of inflammation by the application of flame alone. This subject is about to receive complete investigation.

13. The smallest proportion of the fire-damp experimented with (from the nine-foot Wigan mine) which became ignited and produced explosive effects, when passing a naked lamp flame at a velocity of 600 feet per minute, by having suspended in it the most sensitive of the Seaham dusts, was 2·5 per cent. The most sensitive coal-dust from Leycett furnished a mixture which exploded when passing the flame, under corresponding condition, with air containing only 2 per cent of fire-damp. A mixture of 2·75 per cent of fire-damp with air was ignited by the lamp through the agency of a perfectly non-combustible powder (calcined magnesia).

In a current moving at a velocity of only 100 feet per minute, the Leycett coal-dust, suspended in air containing only 1·5 per cent of fire-damp, became ignited by the lamp flame, the ignition extending throughout the mixture.

14. The accidental presence of a proportion of fire-damp which must have been considerably below the smallest above specified, caused one of the most inflammable of the coal-dusts (from Leycett) to become inflamed and to carry fire some distance, when a small powder-charge was fired from a cannon while the dust was travelling.

15. The sensitiveness to ignition of a mixture of air with a small proportion of fire-damp is considerably increased if the source of heat is increased.

16. The results of the experiments with Seaham and other dusts appear to have demonstrated—

(*a.*) That coal-dust in mines not only much promotes and extends explosions in mines by reason of the rapid inflammability of the finely-divided combustible, and of the readiness with which it becomes and remains suspended in air-currents; but

(*b.*) That it may also be itself readily brought into operation as a fiercely-burning agent which will carry flame rapidly as far as its mixture with air extends, and will operate even as an exploding agent, *through the medium of a proportion of fire-damp in the air of the mine, the existence of which, in the absence of the dust, would not be attended by any danger.*

(*c.*) That dust in coal-mines, *quite apart from any inflammability which it may possess*, can operate in a distinct manner, as a finely-divided solid, in determining the ignition of mixtures of only small proportions of fire-damp and air, and consequently in developing explosive effects.

(*d.*) That a particular dust in a mine (such as the Seaham N dust) may therefore be a source of danger, even though it contains only a small proportion of coal or combustible matter. Although the explosion which may occur through the agency even of a non-combustible powder, in the manner described, may be of very mild or feeble character in the first instance, it may be almost at once increased in magnitude and violence by coal-dust which the first ignition will raise and bring into action.

17. The proportion of fire-damp required to bring dust in a mine into operation as a rapidly burning or exploding agent, even upon a small scale, and with the application of a small source of heat or flame, is below the smallest amount which can be detected in the air of a mine, even by the most experienced observer, with the means at present in use, as has been already demonstrated by the experiments of Mr. Galloway. Indeed, with dusts of highly sensitive or dangerous character, under those conditions, and very possibly with dusts not more so than the least sensitive of the Seaham samples, *in the presence of a source of considerable heat and flame*, such as a blown-out shot or an overcharged hole would constitute, a small propor-

APPENDIX I.

Samples of Dust collected in Seaham Colliery, 15th, 16th November 1880.

Mark on Sample.	Explosion took place 8th Sept., at 2.20 a.m. — Places where Dust was collected.	Area of Place in Super. Ft.	Cubic feet of Air passing per minute.	Temperature Nov. 17th inst.	Distance in yards from Downcast Pit.
X	Coal-dust taken from Nos. 1 and 2 screens	—	—	—	—
K	Dust from floor of stone drift curve	63	66,850	46°	151
L	Dust taken off timbers of drift curve	63	66,850	46	202
M	Dust from near Maudlin engine, supposed to have been affected by the explosion	100	58,430	47	325
N	Dust from No. 3, Hutton seam, south way	60	13,430	66	897
O	Dust from old incline floor	60	12,960	55	774
P	,, ,, ,, scraped off timber	60	12,960	55	974
Q	Dust scraped off stones on return side of Polka doors	42	600	57	823
R	Dust off side of No. 1 engine plane at long turn	65	25,000	55	935
S	Dust off props and stones at long turn	65	25,000	55	983
T	Dust from floor in No. 1, travelling road	63	25,000	54	690
U	,, ,, stone drift, 3rd east way	70	23,000	62	1929
V	Dust from 3 pillars in bye-side of stone drift, in 3rd east way	65	20,000	67	2246

Temperature in No. 1 Overman's Cabin, 300 yards south-east of No. 1 pit, on day before explosion .. .. 64° F.
Temperature in No. 3 Overman's Cabin, 720 yards west of pit in old West-way end, on day before explosion .. .. 68° F.
Temperature in *Maudlin Seam* 400 *yards*, ditto .. .. 69° F.
13 samples, marked as above, sent by rail to-day to Woolwich.
10 samples, larger quantities, sent to Wigan.
3 samples, L, P, Q, marked X, not sent to Wigan.

(Signed) Thomas Bell,
19th November, 1880.

tion of fire-damp, the possible existence of which in the mine might not be in the least suspected, may serve as the inciting cause to the development of an explosion of coal-dust.

18. In the complete absence of fire-damp coal-dust exhibits some tendency to become inflamed when passing a very large lamp flame at a high velocity; if exposed to the action of a large volume of flame, such as produced by the explosion of freely exposed gunpowder or gun-cotton, it exhibits, in addition, a decided tendency to carry or propagate flame. But, so far as can be determined by experiments on a moderate scale, this *tendency* (which was exhibited by Seaham X, K, and S dusts, and still more by the more sensitive Leycett dust) is of limited nature, and very different indeed from the *property* of carrying or propagating flame, which even comparatively non-sensitive dusts possess, *in the presence of a very small quantity of fire-damp*.

In conclusion, it may be admitted as possible that, with the large volume of flame, and the great disturbing effect, of a blown-out shot, as the initiatory cause of the ignition of dust, and its suspension in the surrounding air, such inflammation may, in the complete absence of fire-damp, be propagated to a greater distance than the results of small experiments would warrant one in assuming. But it can scarcely be maintained that the air of a mine in which the coal gives off gas at all can be, at any time, *free* from fire-damp; and as the existence of very small and unsuspected quantities of that gas in the air of a mine may suffice to bring about the ready propagation of flame by coal-dust, and thus to develop violent explosive effects, it would appear needless to assume that coal-dust may, in the entire absence of fire-damp, give rise to explosions, even of only limited character, in coal-mines, in order to account for casualties which cannot be ascribed to the existence of accumulations or sudden outbursts of fire-damp.

F. A. Abel.

March 23, 1881.

Appendix II.

Memorandum of Points for Analysis and Experiments with respect to Coal-dust or other dust in Seaham Colliery.

(*Accompanying the Letter of the Under Secretary of State for the Home Department to Mr. Abel, dated November 9th*, 1880.)

A. Samples of *burnt dust* found in the mine after the explosion, to be analysed with a view to an opinion whether such burnt dust is—

(1.) The ash or product of dust burnt by an explosion of fire-damp; or

(2.) Is the remains or product of dust which has itself been explosively burnt (with or without fire-damp) whilst suspended in the air.

B. Samples of *unburnt dust* to be collected in the mine and analysed, and also subjected to experiments, with a view to try—

(1.) How far the presence of such dust suspended in the air or lying strewn upon the ground or timbers in an enclosed gallery intensifies an explosion of fire-damp or extends the area of the effects of such explosion; and

(2.) How far such coal-dust in suspension in the air is capable of mischievous explosion (*e.g.*, by a shot or by passing through a ventilating furnace without the presence of gas); and

(3.) What are the effects of a shot fired in a gallery (such as the air-ways of a colliery) in causing the disturbance and suspension in the air of such coal-dust lying on the floor or timbers of the gallery.

NOTE ON THE SPECTRUM OF CARBONIC ACID.*

By Charles Wesendonck, Berlin.

Communicated by Professor Helmholtz, For. Mem. R.S.

The well-known spectrum first observed by Mr. Swan at the inner cone of a number of flames produced by burning liquid and gaseous combinations of carbon, has been ascribed by Messrs. Attfield† and Watts‡ to the element carbon itself; while several other natural philosophers—amongst whom I only mention Messrs. Thalèn and Ångström,§ P. Smyth, Liveing‖ and Dewar¶—believe it to be due to some combination of carbon with hydrogen. The fact that the bands and lines of Swan's spectrum are seen even when oxide or binoxide of carbon is made luminous in a Geissler tube by means of an electric current, the last-named gentlemen explain as being caused by the gases not having been entirely deprived of all moisture when introduced into the vacuum tube. I therefore believed it to be not altogether without interest to make some experiments on carbonic acid dried with the utmost care. For this purpose I used a mercurial pump, as invented by Professor Toepler, with some slight changes in the original construction indicated by Dr. Hagen,** which enables us not only to obtain the most perfect vacua, but also to avoid every cock or junction by slided pieces, which must be greased in order to be hermetic, so that no vapours and gases containing carbonic matters arising from the grease, either by increase of temperature or by the electric current when passing the vacuum tube, would render impure the carbonic acid, as is the case with the common Geissler pumps. Carbonic acid was produced in the well-known manner from marble and diluted muriatic acid in a Pippian apparatus, well washed with water in a large Woolf's bottle, and then sent through concentrated sulphuric acid, three tubes of U form containing chloride of calcium and a double tube half filled with phosphoric anhydride. To this last tube were fastened, by means of sealing, two Geissler glass cocks, being on the other side fastened by sealing to a valve of sulphuric acid, that prevented all vapours coming from the cocks from entering the vacuum tube. After all air had been driven and pumped out of the whole apparatus, the spectrum tube was exhausted to the highest possible degree, in order to free it from all moisture adherent to the sides of the glass. This, however, was found to cause some difficulty, for the green hydrogen line was seen with great constancy in high vacua, even if not the least trace of it could be remarked when the carbonic acid spectrum could be seen brightly. I soon recognised that the more the gas had been deprived of moisture, the further had the exhaustion to be carried on to render the said line visible again, but for a long time I could not quite get rid of it. By repeatedly filling and exhausting the vacuum tube, in doing which the gas naturally was only permitted to pass very slowly through the phosphoric anhydride tube, and the spectrum tube was heated to the highest degree possible, I at last arrived at such a degree of perfect dryness as no more to give any trace of the fatal green line, not even if the tube was exposed to high temperature; this, indeed, always had the effect of driving into the vacuum some matter adherent to the sides of the glass, and causing the illumination of the tube, when this has been so far exhausted as no longer to permit any current to pass, to reappear. But the brilliant mercury spectrum seen under such circumstances showed nothing of a hydrogen line. Nevertheless, after this exceedingly high degree of dryness

* A Paper read before the Royal Society, June 16, 1881.

† *Phil. Trans.*, vol. cliii., Part 1, 1862.

‡ *Phil. Mag.*, ser. 4, vol. 38, 1869.

§ *Nova acta Upsal.*, ser. 4, vol. 9.

‖ *Phil. Mag.* (5), 8, 1879.

¶ *Proc. Roy. Soc.*, vol. 30, 1880.

** *Wiedemann's Annalen*, Neue Folge, Bd. 12, 1881.

had been obtained, when there was some gas admitted into the spectrum tube and this again exhausted, the fatal line was feebly seen, showing clearly that the gas had not been entirely deprived of its moisture by its passing through the system of drying apparatus. I therefore finally only experimented with such carbonic acid as had been in perpetual contact with the phosphoric anhydride during at least twelve hours, and it was not till then that I got rid of every trace of the hydrogen lines. When making the experiments that I believe to be decisive, I always took care to convince myself, by rarefying, that not only the gas had remained perfectly dry, but also that the current had not introduced any trace of hydrogen or hydrocarbon when passing through the tube, for both would have been discovered in the high vacuum by the appearance of the green line, the spectrum of hydrogen being by no means suppressed by that of carbon in such a vacuum, as I most clearly observed when experimenting with olefine gas, which in a very rarefied state shows from the beginning of the current's passage a very distinct spectrum of the first order of hydrogen, besides the one of carbon. If the bands and lines observed by Swan really belonged to hydrocarbon only, they could not have appeared in our case, but they did appear very distinctly, and clearly, as soon as the density of the gas became great enough to oblige the current to pass a spark through the vacuum tube; and even not less brightly was Swan's spectrum seen at much lower pressures by using a Leyden jar. The capillary tube in which the said spectrum alone was seen was then wholly filled by the luminous discharge; no real spark appeared in this case, while the wide parts of the spectrum tube showed Mr. Watts's second carbon spectrum. It is these last-mentioned experiments only, made by use of a Leyden jar, that I believe to be decisive, and to prove irrefutably that Swan's spectrum cannot be ascribed solely to hydrocarbon. As to the phenomenon shown by sparks, it is not quite so convincing; for, accepting Mr. Wuellner's* ideas, one could object that the spark affecting but a set of molecules of infinitely small transverse section could have carried forth from the electrodes an exceedingly small quantity of hydrogen, which would quite escape observation when expanded throughout the whole vacuum tube, but would be sufficient to induce the hydrocarbon spectrum in the line of the spark, which explanation, however, I do not think to be at all probable. The tube used in these experiments was of common size; the ends of the electrodes, which were of aluminium, had a distance of about 15 centims. from one another. Some results, differing from those just mentioned, were obtained in a wide spectrum tube without capillary tube, the ends of its electrodes being distant about 3 centims. from one another. The spark, then, no more gave appearance to Swan's spectrum, even when the carbonic acid was not dried with the utmost care, as in the above-mentioned researches, but there were seen the enlarged maxima of Watts's second spectrum, which I have shown by some researches, of which a short account has been published in the *Monatsberichte der Berliner Academie*, October heft, 1880, to be generally due to the continuous form of discharge according to the nomenclature of Messrs. Thalèn and Ångström. If the density of the gas be still increased, there flashes a very brilliant line spectrum, never before observed by me, in a tube of common size. These facts, at all events, show that there exists some relation between the different orders and forms of spectra and the conditions of discharge, probably, as is my opinion, the quantities of electricity sent through the unit of space in the unit of time, till now unknown to us, and that will doubtless become clear as soon as the causes governing spark discharges shall be better recognised—a subject on which Sir W Thomson† says that it is difficult even to conjecture an explanation.

* Wuellner, "Lehrbuch der Experimental Physik," vol. ii., p. 250, &c.

† Papers on "Electrostatics," &c., p. 247.

DETERMINATION OF CHROMIUM IN CHROME IRON ORE.

By H. N. MORSE and W. C. DAY.

WHEN a determination of the chromium only is sought, the decomposition of chrome iron ore, according to our experience, can be best accomplished by fusing the material with potassium hydroxide in a wrought-iron crucible.

The method here described has, without exception, given us satisfactory results. From 6 to 10 grms. of potassium hydroxide are placed in a wrought-iron crucible (having the form of the ordinary porcelain crucible and a capacity of about 100 c.c.) and gently heated until the evolution of steam ceases and the fused mass becomes tranquil. After cooling, the finely pulverised material, weighing not more than 0·5 grm., is placed upon the potassium hydroxide and evenly distributed over the surface. A flame just sufficient to thoroughly fuse the alkali is applied to the uncovered crucible, and the contents, as long as they remain in a fluid condition, frequently stirred with a piece of iron wire, which is allowed to remain in the crucible. The decomposition progresses rapidly, and the potassium hydroxide together with the soluble products of the decomposition soon begins to rise upon the sides of the crucible, where it deposits itself in forms somewhat resembling the cauliflower. Within two or three hours the decomposition is complete, and the bottom of the crucible becomes dry. The crucible is then turned upon its side and the temperature of its under surface raised to a dull red heat. The incrustation on the interior of the crucible does not fuse at this temperature, but becomes rapidly yellow, owing to the oxidation of the chromium to chromate. At the end of two or three hours the oxidation is perfect. Portions of the incrustation retain a greenish colour, however long the heating is continued; but this is due to the presence of iron or manganese and not to unoxidised chromium.

After cooling, the crucible is placed in a porcelain evaporating dish and the contents removed by means of hot-water. The solution, which at first has a greenish appearance owing to the presence of iron dissolved in the caustic potassa, is heated for some time in order to effect complete precipitation of the iron. The filtrate, which has a clear yellow colour, is rendered slightly acid with pure dilute nitric acid, the aluminum precipitated with ammonia and washed by decantation. The chromate of potassium is then reduced and the silica rendered insoluble by evaporating to perfect dryness with an excess of hydrochloric acid. The residue is moistened with hydrochloric acid and treated with water.

It only remains to separate the chromium in the filtrate from magnesium and to determine it as chromic oxide. To do this we have preferred in each instance to first precipitate with barium carbonate.

We give here the data of twelve determinations upon material whose origin is unknown to us. Four of these (1 to 4) were made by ourselves, four (5 to 8) by Mr. A. G. Palmer, and the remainder (9 to 12) by Mr. W. S. Bayley, both students in this laboratory. The analyses reported were in each case made consecutively.

	Wt. of Ore Taken.	Wt. of Cr_2O_3 Found.	Percentage.
1.	0·3250	0·1343	41·32
2.	0·3465	0·1433	41·35
3.	0·3248	0·1343	41·36
4.	0·3383	0·1392	41·14
5.	0·2723	0·1120	41·12
6.	0·3955	0·1629	41·19
7.	0·3311	0·1358	41·02
8.	0·3285	0·1290	41·23
9.	0·3387	0·1392	41·10
10.	0·2995	0·1235	41·25
11.	0·3606	0·1478	41·00
12.	0·3007	0·1236	41·11

In order to assure ourselves that complete decomposition and oxidation had been effected, the same method of treatment was applied to the iron and aluminum precipitates as to the original material. This was done in the case of nine of the analyses here reported. But in no case was there any trace of chromium obtained from them. The average loss of the iron crucibles is about 0·2 grm. Much coarser material can be successfully analysed by this than by the other methods in use. Its simplicity and economy also recommend it.

The only method on record, so far as we know, involving the use of potassium hydroxide for the decomposition of chrome iron ore, is that proposed by H. Schwarz,* who recommended fusion with potassium hydroxide in a silver crucible and addition of potassium chlorate to the fused mass. The decomposition by this method is doubtless easy and complete, but the rapidity with which the crucible is destroyed renders the method wholly impracticable.—*American Chemical Journal.*

Johns Hopkins University, May, 1881.

NOTE ON SULPHURETTED HYDROGEN.

By P. CASAMAJOR.

In 1873, Mr. William Skey, Analyst to the Geological Survey of New Zealand, published some interesting observations† on the production of sulphuretted hydrogen when a voltaic couple is formed with zinc as the positive, and a metallic sulphuret as the negative plate. When placed in contact with zinc or in communication with this metal, by means of a wire, many sulphurets give sulphuretted hydrogen very freely with sulphuric acid or hydrochloric acid, which alone would not give any in contact with these acids. This happens with galena and sulphuret of copper. I have had occasion lately to apply these researches of Mr. Skey to the production of sulphuretted hydrogen from sulphuret of iron, which refused to give it in presence of sulphuric acid diluted with ten times its volume of water. I believe that the greater part of the sulphuret of iron sold to chemists possesses this resistance to acids. I have lately found none that gave sulphuretted hydrogen easily, and I had accumulated several pounds possessing this undesirable quality.

After a few trials I was able to obtain an abundant supply of sulphuretted hydrogen from any sample of sulphuret of iron by proceeding as follows:—

Enough mercury is put in a bottle to cover the bottom entirely. Over this, diluted sulphuric acid is poured, and some pieces of zinc are thrown in, which immediately sink into the mercury, forming a zinc amalgam with great excess of mercury. No action takes place between the zinc and the acid. If, now, a few pieces of sulphuret of iron are thrown in the bottle, they will sink to the mercury, and a copious production of sulphuretted hydrogen will take place from the surface of the sulphuret. This production will continue with remarkable regularity until either the zinc, the sulphuret of iron, or the sulphuric acid is exhausted. As to the mercury, it only intervenes indirectly in the reaction, and it does not require to be renewed.

In place of sulphuret of iron, I have tried galena, iron pyrites, and copper pyrites. These all give sulphuretted hydrogen, but very slowly. With galena, the action soon ceases, as the mineral becomes coated with sulphate of lead. By leaving galena in contact with liquid zinc amalgam for several hours, the surface of the mineral becomes coated with a bright coat of lead amalgam.

With iron and copper pyrites, comparatively little sulphuretted hydrogen is given off, but there is a considerable production of hydrogen. In this case the sulphurets act mainly as conductors, in the same manner as a piece of retort carbon.

* *Liebig's Annalen*, 69, 212.
† CHEMICAL NEWS, vol. xxvii., p. 161.

ON MICROLITE FROM AMELIA CO., VIRGINIA.

By F. P. DUNNINGTON.

The mineral which is the subject of this examination was collected at the mica mines, two miles north of Amelia C.H., by Prof. W. M. Fontaine of this University, who gives the following notes of its occurrence and associations:

"This mineral occurs with others imbedded in a vein of 'Gigantic Granite' (so called because of the essential minerals of the granite being crystallised in large masses), which is enclosed in gneiss and mica schist, with the general characters of the Montalban series. Schorl is very abundant in the adjoining wall-rock.

"The associated minerals are as follows:—

"Beryl, abundant, sometimes in large crystals eight to ten inches in diameter; fluorite and columbite not uncommon; amethystine quartz, occasional; apatite, rare. In addition to which are the large crystal masses composing the vein, quartz, orthoclase,* and mica (of which last the sheets are frequently three feet across, and for which the vein is worked)."

Prof. Fontaine presumed the mineral in question would prove of interest, and handed it over to me for further examination, the result of which is as follows:—

It is found in single crystals varying in dimensions from one-tenth to three-quarters of an inch, and in larger crystalline masses of which one was obtained weighing *eight pounds*. It occurs crystallised in octahedra of the isometric system, some of the edges of which measure two centimetres; the face 1 is principally developed, and with it are the truncations made by O, 3-3 and *i* (Dana).

It has the following properties:—Hardness a little less than 6; specific gravity, 5·656; lustre, glistening resinous; colour, wax yellow to brown; streak, pale ochreous yellow, subtranslucent; fracture conchoidal and very brittle.

Heated in a closed tube it decrepitates and gives off a little water. When ignited it glows momentarily as if taking fire. Before the blowpipe it colours the flame a reddish yellow, is infusible, and on cooling is coloured pale yellow, and is without lustre. With the borax bead, and also with that of salt of phosphorus, in both flames it gives a glass yellowish when hot, colourless when cold. In both flames the saturated bead of salt of phosphorus is yellow when hot and greenish yellow when cold. It is not attacked by strong hydrochloric acid, but is decomposed slowly by concentrated sulphuric acid and also by fusion with caustic potash. It is readily decomposed by fusion with acid potassium sulphate. Fused with potassium nitrate and sodium carbonate, it does not give the manganese reaction. The moist metallic acids boiled with hydrochloric acid and tin afford a pale blue colour.

The finely pulverised mineral was fused at a low red heat in a platinum crucible with eight parts of acid potassium sulphate. Four portions of about two grms. each were thus fused, and all the constituents except the acids, alkalies, and water, were then determined from the sum of these = 8·3370 grms. of the mineral.

The metallic acids, insoluble in dilute hydrochloric acid, were well washed and then digested with yellow ammonium sulphide and washed, and then *separately* washed with dilute hydrochloric acid, and finally washed with water. The oxides of tin and tungsten obtained from the ammonium sulphide solution were weighed together, then fused with sodium carbonate and a little potassium cyanide and washed. The tin dissolved out by hydrochloric acid, re-precipitated by hydrogen sulphide, washed, ignited, and weighed, the tungsten being obtained by difference.

The insoluble metallic acids were treated with hydrofluoric acid and acid potassium fluoride, HKF_2, and the double salt, $2KF,TaF_5$, crystallised out according to Marignac's process; the crystals obtained were washed free of niobium and then dissolved and re-crystallised. The washings and mother-liquors were evaporated to a small bulk

* Ratio of potash to soda = 11 to 4.—F. P. D.

and the crystals so obtained purified as before, and finally the filtrate again treated as before, there being obtained from one portion :—

Ta_2O_5, 4·844. Sp. gr. = 7·77. and after prolonged ignition = 7·96.

Nb_2O_5,* 0·558.

giving the ratio 8·68 to 1.

And from another portion :—

Ta_2O_5,† 5·189

Nb_2O_5, 0·577. Sp. gr. 4·20, and after prolonged ignition = 4·23.

giving the ratio 9 to 1.

The mean of these determinations gives the ratio by weight :—

Ta_2O_5 to Nb_2O_5 = 8·84 to 1.

If these oxides when mixed do not change their volume on ignition, the mixed acids as separated should have had sp. gr. = less than 7·6, whereas after prolonged ignition they had sp. gr. = 7·86. I propose therefore to further examine this apparent combination of so closely related elements.

All the above specific gravities were taken between 11° and 14° C., and referred to water at this temperature.

The cerium metals proved to be present in too small amount to admit of accurate separation; they consist in about equal portions of cerium and didymium, and probably entirely of these, as lanthanum was not identified.

None of the lines attributed to erbium were found with the earths of the yttria group.

A portion dissolved in sulphuric acid under carbon dioxide decolourised a very little potassium permanganate, corresponding in amount to and probably due to the cerium as cerous oxide (C_2O_3); therefore the uranium and iron are taken as Ur_2O_3 and Fe_2O_3.

Fluorine was estimated by the volumetric method of Mr. S. L. Penfield,‡ and since, in order to decompose the mineral, the sulphuric acid was heated to 175° C., and for many hours, I took special precautions to condense the volatilised sulphuric acid and then deducted the minute amount of sulphuric acid found in the titrated liquid.

The water was given off below a red heat.

No trace of lead or of manganese was found.

The analysis gave the following results :—

Ta_2O_5	68·43
Nb_2O_5	7·74
WO_3	0·30
SnO_2	1·05
CaO	11·80
MgO	1·01
BeO	0·34
U_2O_3	1·59
Y_2O_3	0·23
Ce_2O_3 } Di_2O_3 }	0·17
Al_2O_3	0·13
Fe_2O_3	0·29
Na_2O	2·86
K_2O	0·29
F	2 85
H_2O	1·17
	100·25
Deduct O replaced by F	1·20
	99·05

Considering the bases as replacing equivalent amounts of calcium and neglecting the water, we have the following atomic relations :—

Ca.	Ta.	Nb.	Sn and W.	F.	O.
32·9	30·9	5·8	0·83	15	118·6

If we exclude the Fe_2O_3 and Al_2O_3 as uncombined, as they most probably are, the following formula may be deduced :—

$$\begin{cases} 3(Ca_2Ta_2O_7) + NbOF_3 \\ m(CaWO_3) \end{cases}$$

It may be remarked that in *most* of the reported analyses of pyrochlore the fluorine and alkaline metals nearly correspond in number of atoms, which is clearly not so in this case, while the relation between the niobium and fluorine points to the association of these elements under the familiar form of $NbOF_3$.

To some of the analyses of pyrochlore, considered by Prof. C. Rammelsberg in his extended paper* on tantalates and niobates, he assigns the formula :—

$$\begin{cases} m(R_2Nb_2O_7) \\ n(RTiO_3) \\ o(NaF) \end{cases}$$

From the results of the above analysis and also from its crystalline habit, it therefore appears that this mineral is the one which has been described by Prof. C. U. Shepard as microlite, although it proves to have a composition different from that originally supposed by him, and corresponding to that suggested by Prof. Brush, viz., essentially a calcium tantalate.

The minute size of the crystals in which it was previously found fully warranted the name microlite, but in view of the present facts it appears rather inappropriate.† —*American Chemical Journal*, May, 1881.

University of Virginia, April, 1881.

* Containing some Ta_2O_5. † Containing some Nb_2O_5.
‡ *American Chemical Journal*, i., 27.

* *Journal Chem. Soc.*, Series 2, x., 203.

† A private communication from Prof. E. S. Dana informs me of a recent analysis by Nordenskiöld, of a mineral from Utö, in size of crystals a true microlite, who found in it :—$Ta_2O_5(Nb_2O_5)$, 77·3; SnO_2, 0·8; CaO, 11·7; MuO,FeO, 7·7; MgO, 1·8; total, 99 3.—F.P.D.

NOTICES OF BOOKS.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1879. Washington : Government Printing Office.

This volume contains in addition to a number of memoirs dealing with ethnological and archæological subjects, a biography of James Smithson, whose merits as a chemist, physicist, and mineralogist, the friend and associate of such men as Davy and Wollaston, have been remarkably overlooked in this his native country. He is often considered to have been an Englishman who had become naturalised in the United States. The fact is, on the contrary, that his long life was pased in this country and on the Continent, and that he had not a single correspondent in America. Like his friend Cavendish, he had, at one time, intended leaving his fortune to the Royal Society, but some slight difference with the Council led him to alter his determination.

Perhaps the most important paper in this volume, from our point of view at least, is the course of lectures on "The Present Fundamental Conceptions of Physics," as delivered by Prof. Pisko, at Vienna. On the statement that "one single natural force, or rather one single original universal motion, is recognised, which manifests itself as cohesion, adhesion, chemical affinity, gravitation, heat, &c.," the editor remarks, "This hypothesis is a remarkable instance of premature generalisation. In the Smithsonian Report for 1876 (pp. 275 to 279) reasons were given for believing that gravitation cannot be resolved into any form of *motion*, and further, that without an inscrutable "force" underlying all motion and antecedent to it, no rational conception of dynamics is possible. Without the ultimate fact of elasticity in material elements, neither transformation of motion nor conservation of energy could have any conceivable basis."

Spon's Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products. Division IV. Edited by Charles G. Warnford Lock. London: E. and F. N. Spon.

This division includes not a few heads of great importance to the industrial chemist, such as inks, leather, manures, matches, mordants, oils and fats, perfumes, &c.

The article on inks includes black writing ink, copying-ink, coloured inks, sympathetic ink, marking ink, printing, engraving, and lithographic inks. Under the head writing inks it might have been useful to point out the distinction between such as are perfect solutions, and such as contain more or less insoluble matter in a state of suspension. In the latter class, gum, or some similar body, is necessary to prevent the colouring-matter from subsiding. In those inks, on the contrary, which are true solutions, gum is, to say the least, absolutely useless.

Under "Jute" we find reference to recent improvements in the methods of dyeing, which, however, are not described.

The article on leather and its manufacture is carefully and elaborately compiled; the morphology and the chemical composition of hides are treated at some length, and with the aid of several illustrations. We do not, however, find any mention of the respective parts played by tannin and by phlobaphene; nor is the newly-introduced system of chrome-tannin discussed.

Manures, natural and artificial, are very fully described. The fish guanos of Norway are stated to contain 25 to 30 per cent tricalcic phosphate, and 7 per cent of nitrogen. We have met with samples containing 10 per cent and upwards. Concerning blood, the writer pronounces it "difficult to remove even a portion only of the water."

An excellent and elaborate account is given of the phosphates occurring in commerce, with their localities, and their percentages of phosphoric acid.

The article on matches deals chiefly with the mechanical part of the manufacture. We find no reference to the use of amorphous phosphorus, recommended as preferable to ordinary phosphorus on sanitary grounds, nor to the still better proposal to dispense with phosphorus altogether, thus preventing the waste of plant food.

The section on "mordants" is of a practical character, and gives as much sound information as the space will allow.

Under the head "Narcotics," we find much interesting matter. It is singular to find what a prodigious quantity of soil and of plant food is taken up in the production of articles which can scarcely be said to supply any real want of the human system, and none of which were consumed by the most civilised nations of antiquity.

It is an unfortunate circumstance that the cultivation of narcotics is more remunerative than that of food-plants. In India, wheat and other cereals in the best soils pay 3 rupees per beegah of land, whilst poppies pay from 10 to 20 rupees, and even higher sums. The peasantry engage in the culture of their own free will, and are well remunerated. Both the people and the government must, however, look forward to the loss, or the great curtailment, of this trade in no distant future. Persia has entered the Chinese market as an eager competitor, and exports to that country an increasing quantity of opium, which in 1879 had already reached the value of five millions sterling. China herself, which we are sometimes told is anxious to put a stop to the importation of opium, produces five million lbs. weight annually, importing from India and Persia about 12 million lbs. The writer observes: "Though the abuse of the drug leads to evil consequences—by no means equalling, however, those of the abuse of alcohol in this country—its moderate use is extremely beneficial, if not absolutely necessary, in the malarial climate of China, where almost the whole is consumed, and the immunity of opium smokers from diseases of the bronchial tubes and lungs, so common among non-smokers, is remarkable. The real remedy for excessive opium smoking in China lies in the development of the resources of the country, enabling the inhabitants to occupy healthy houses and consume wholesome food; the abuse of opium would then die out of China, as the abuse of laudanum died out of Lincolnshire after the fens were drained. An antidote for opium smoking is the use of coca."

We must add the remark that the abuse of laudanum still flourishes in some districts of Lincolnshire, *e.g.*, Horncastle, unless a great change has taken place within the past ten years.

The article on oils and fats is exceedingly elaborate and valuable. We have only space to make the suggestion that a trifling addition of salicylic acid—too small to affect the flavour—would very probably enable palm oil to be brought over to this country free from rancidity. Nothing more is wanted to enable it to rank as an article of diet decidedly superior to the mixtures of animal fats now so largely used as a substitute for butter.

We are very happy to testify to the value of Spon's Encyclopædia as a work of reference.

CORRESPONDENCE.

ON A NEW METHOD FOR THE ESTIMATION OF NITRATES IN POTABLE WATER.

To the Editor of the Chemical News.

Sir,—Your correspondent, Mr. William Johnstone, does not appear to be able to distinguish between a qualitative test and a quantitative estimation.

In my paper, read before the Society of Public Analysts in March last, I described a method of estimating nitric acid in water by means of the brucine reaction, and so far as I am aware, the brucine reaction has never previously been made quantitative. If Mr. Johnstone will carefully read the paper of Mr. E. Nicholson (Chemical News, vol. xxv., p. 89) that he quotes from, he will find that it is nothing more nor less than a qualitative test, well known to analysts. The author does indeed state that he hopes before long to give a process for the quantitative estimation, but such process has never been given, until the appearance of my paper. In what way, then, my process is only a slight modification of Mr. Nicholson's, I am at a loss to conceive.

I am perfectly aware that many analysts have been in the habit of using the brucine test daily in water analysis, as giving a rough indication of the amount of nitrates present, but that in no way affects my method, which is, in fact, the only one that has been devised for estimating nitric acid, based on the brucine reaction.—I am, &c.,

J. West Knights.

Camtridge, July 13, 1881.

BETA-NAPHTHOL-SULPHONIC ACID.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 288, there is an account of an interesting description, given by Dr. Armstrong to the Chemical Society on June 16th, of a new isomeric beta-naphthol-sulphonic acid, obtained by Dr. Armstrong and Mr. Stallard, by dissolving beta-naphthol in cold concentrated sulphuric acid, and of the derivatives obtained from it by the action of bromine and nitric acid. Will you allow me to state that on March 21, 1881, I filed a Provisional Specification, and on June 21 obtained Letters Patent, dated March 21, 1881, for "Improvements in the Manufacture of Colouring Matters suitable for Dyeing and Printing, and in the Preparation of a New Mono-sulfo-acid of Beta-naphthol and its Salts and Derivatives," a communication to me from abroad from Mr. Carl Rumpff, of Elberfeld (senior partner of Messrs.

Friedrich Bayer and Co), to whom this Patent, together with a subsequent one following up the invention, has been assigned. The Specification describes the preparation of the new acid by the action of strong sulphuric acid on beta-naphthol at ordinary temperature, the mixture heating spontaneously with great rapidity, and requiring to be kept down to below 50° to 60° C., as, if the temperature rise only a few degrees higher, and there be an excess of sulphuric acid present, the new mono-sulpho-acid passes with rapidity wholly over into Schaefer's acid (which is always produced along with it). The new acid is distinguished in the Specification from Schaefer's by the temperature of formation; by the difference of its behaviour to nitric acid (giving, as Schaefer's does not, separable nitro products, the potassium salts of which are crystallisable compounds, dyeing wool and silk of a beautiful yellow); and by the different solubilities of the neutral soda salts of the two acids in spirits of wine at 90°, the salt of Schaefer's acid being nearly insoluble therein, while that of the new acid, on the contrary, dissolves with great facility, settling, as the alcohol cools, in fine large and extremely hygroscopic crystals, which contain spirit. The new acid gives with the diazo and tetrazo bodies a series of colouring matters fast against soap and light, the shades of which are, on the whole, yellower than those of the azo and diazo-azo dyes prepared from the common beta-naphthol-mono-sulpho-acid. The new acid also forms dyes in a variety of other combinations analogous to those in which the isomeric beta-naphthol-disulpho-acids have already been employed.

I do not doubt the identity of the new acid patented by me with that independently (but subsequently) discovered by Dr. Armstrong and Mr. Stallard. I mentioned to Dr. Armstrong some time ago, when he told me of his discovery, that I had already patented the new acid and its nitro-products and colour-combinations, and I now wish, on behalf of Mr. Rumpff, to mention the prior discovery and the patents, in case colour manufacturers should suppose that the preparation and applications of the new acid are open to the world.—I am, &c.,

J. A. Dixon.

175, W. George Street, Glasgow.
June 16, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xix., Part 4.

Methods for Determining the Permeability of Soils.—F. Seelheim.—An illustrated memoir exceeding thirty pages in length, and not capable of abstraction.

Determination of Sulphur in Sulphur Ores.—G. Lunge.—The author considers the process of Fresenius (*Zeitschrift*, xvi., 339) too tedious except for use in disputed cases. He gives an experimental justification of his method as described in his "Treatise on the Manufacture of Sulphuric Acid and Alkali," i., p. 92, as sufficiently accurate for the laboratories of manufacturing establishments. He particularly recommends the funnels made by Oppermann, of Hohenbüchen, near Delligsen, and the filter-paper of Rieckmann, in Hanover, as economising time, and rendering the use of a water air-pump or a Piccard's filtering arrangement superfluous.

Determination of Ash in Coal and Coke.—A. Wagner.—If coal is heated at first very gently the residue may be perfectly incinerated in a platinum crucible in a few hours' time by the heat of a common gas-burner. Samples very rich in ash may require the use of the blast towards the end of the process. Coke requires to be ignited in a muffle furnace.

Trustworthiness of the Analyses of the Gases of Smoke.—A. Wagner.—The author points out several sources of error by which the results must be vitiated to an appreciable extent.

Analysis of Gunpowder.—A. Wagner.—The author considers that the fear expressed by R. Fresenius lest, on drying the residue at 100°, after dissolving out the saltpetre, a little sulphur may be volatilised, to be needless.

Gravimetric Method of Determining Phosphoric Acid.—Dr. B. Peitzsch, Dr. W. Rohn, and Dr. P. Wagner.—Already inserted.

A Simple Apparatus for Collecting the Nitrogen in Volume-Determinations.—W. Städel.

A Simple Aspirator.—Fried. Lux.

Flavescine; a New Indicator.—Fried. Lux.

Preparation of Hydrochloric Acid.—Dr. L. L. de Koninck.—These four memoirs cannot be reproduced without the accompanying cuts.

Solution of Bromine as a Reagent.—Dr. L. L. de Koninck.—Already inserted.

Method for the Qualitative Separation of Cobalt and Nickel.—Fr. Reichel.—Already inserted.

Extraction-Apparatus.—O. Scheibler.—This apparatus is destined for extracting beet-root with alcohol, for the determination of sugar. It agrees in principle with that of Tollens (*Zeitschrift*, 17, 329).

Self-acting Washing Arrangement.—Jean de Mollins.—This apparatus cannot be described without the accompanying illustration.

The Determination of Coloured Acids.—F. Salomon.—The author makes use of an apparatus resembling in principle Scheibler's calcimeter, the acid being allowed to act upon a bicarbonate, and the liberated acid being measured.

Determination of the Melting-point of Organic Compounds.—G. Röster.—Taken from *Berichte der Deutsch. Chem. Gesell.*, 13, 580.

An Improved Pinchcock.—MM. Knies and v. Jüptner.—From *Chem. Central-blatt*, 3rd Series, 11, 179.

Occurrence of Gold Chloride in Commercial Solutions of Platinum Chloride.—W. Gintl.—This impurity may amount to 3 per cent, and may occasion errors in the determination of potash. The author recommends that such solutions should be repeatedly shaken up with ether, which dissolves all the gold chloride and but little of the platinum salt. From the ethereal solution the gold is recovered by evaporation, and is then re-dissolved in chlorine water.

Impure Sulphuric Acid.—W. Gintl has found in acid purchased as "pure" as much as 5 per cent of ammonia. F. Selmi shows that for the entire removal of arsenic from sulphuric acid it is necessary to treat with hydrogen sulphide, to dilute the clear residue with half its volume of water, and to rectify over lead chloride.

Adulterations of Coffee.—H. Hager.—The author gives instructions for the detection of dyed, sea-dipped, and factitious coffee beans in the raw state, and for the recognition of chicory, lupines, acorns, &c., in roasted and ground coffee. The seeds of *Cassia occidentalis*, which have been recently introduced as an adulterant, are detected microscopically by their smooth, polished surface.

Determination of Ash in Gun-cotton.—M. Hess.—The author melts pure paraffin in a platinum capsule, adds a weighed quantity of gun-cotton, and ignites it when saturated from above. The contents of the capsule burn as quietly as pure paraffin. The carbonaceous matter remaining is then incinerated.

Examination of Morphine Hydrochlorate.—H. Tausch.—The pure salt can be heated without decompo-

sition or change of colour to 130°, at which temperature impure specimens turn brown.

Contributions to the Quantitative Spectral Analysis of Blood.—M. Hufner.—The quotient $\frac{Ao}{Ao'}$ has the same value for crystalline oxy-hæmoglobin and for diluted blood; Ao denoting the absorptive ratio for the region—

D 32 E – D 53 E,

and Ao' that for the region D 63 E – D 84 E.

Determination of Urea by means of Sodium Hypobromite.—M. Fauconnier.—In presence of grape-sugar urea yields the theoretical quantity of gas as stated by Méhu. The latter proposes to add to the urine, sugar equal to ten times the weight of the urea present.

Determination of Hippuric Acid in Urine.—M. Lœbisch.—An examination of the process of Cazeneuve.

Determination of Acetic Ether in Urine.—M. Quincke.—The author makes use of a calorimetric process based on the dark red colour produced by an addition of ferric chloride. He doubts, however, the identity of the compound found in urine with ethyl-diacetic acid.

Occurrence of Glycerin-phosphoric Acid in Normal Human Urine.—M. Sotnitschewsky.—This acid, though in very small quantities, belongs to the constant ingredients of urine.

Volatile Phenols in Urine.—M. Brieger.—These phenols are chiefly para-cresol with small quantities of phenol and traces of ortho-cresol.

Occurrence of a Reductive Agent in Urine after Ingestion of Sodium Benzoate.—M. Salkowski.

Demonstraion of Preformed Urobiline in Urine.—M. Salkowski.

Justus Liebig's Annalen der Chemie, Band 205, Heft 3.

Amidoid Derivatives of Hydroxylamin. — This memoir consists of three portions: on ethyl-hydroxylamin and the determination of the vapour-density of some of its derivatives, by Dr. O. Gürke; a paper by the same author on α- and β-dibenz-hydroxamic ethyl-ester, and α- and β-ethyl-benz-hydroxamic acid, being a contribution to the knowledge of so-called physical isomerism. On his results Prof. Lossen remarks that the existence of such bodies as the modifications of one and the same hydroxylamin derivative does not justify the assumption that metamerism, *i.e.*, difference of properties along with similar composition and identical molecular weight, may exist in such compounds in which the concatenation of atoms within the molecule is perfectly identical. The third portion of the memoir by Dr. Lassar Cohn treats on the conversion of phthalic acid into salicylic acid.

Examination of the Constitution of Certain Alkaloids of the Cinchona Barks.—O. Hesse.—Not capable of useful abstraction.

Propionyl-quinine.—O. Hesse.—This compound forms large, colourless, hexagonal prisms, belonging to the rhombic system, fusible at 129°; rather easily soluble in ether, alcohol, and chloroform, and very sparingly in water. The alcoholic solution on the addition of chlorine and ammonia takes an intense green colour, and if then boiled with potassa the base is resolved into quinine and propionic acid.

Australian Alstonia Bark.—O. Hesse.—The author has isolated and described the bases alstonine (chlorogenine), porphyrine, and alstonidine, and considers that other alkaloids are likewise present.

Gay-Lussac's Hypo-chloro-nitric Acid.—H. Goldschmidt.—It appears from the author's experiments that a compound $NOCl_2$ does not exist among the distillation products of *aqua regia*. What Gay-Lussac regarded as hypo-chloro-nitric acid is merely nitrosyl chloride, having absorbed free chlorine in variable quantities.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. ix., No. 10.

The Solid Constituents of Sea-water. — Ludwig Schmelck.—In the mother-liquor obtained by evaporating down 20 litres of sea-water iodine was detected according to Kœtstorfer's method. The proportion of organic matter, as determined by permanganate, is 0·0025 per cent.

The Permeability of the Soil for Air.—G. Ammon.—If soil is slightly moistened it is rendered more permeable for air. Frost diminishes the permeability of the soil, the more in proportion to its degree of moisture.

The Pollution of the Soil in Paris.—H. Ste.-Claire Deville.—From the *Comptes Rendus*.

Manurial Experiments on Potatoes.—Dr. J. Fittbogen.—Not adapted for abstraction.

Experiments on the Relative Value of Precipitated Phosphoric Acid and Soluble Phosphoric Acid.—Dr. A. Emmerling.—In the loamy soils of Holstein phosphoric acid in the form of precipitated phosphate has approximately half the value of phosphoric acid in the form of superphosphate. On moor soils there is little difference.

Analysis of Cocoa-nut and Palm-nut Meal.—Prof. A. Petermann.—Cocoa-nut meal contains 19·16 per cent of proteine compound; palm-meal 14·98 per cent.

The New Milk-tester.—M. Mittelstrass and C. Jenssen.—This instrument determines the quality of milk by its opacity. The portion operated upon is a mixture of 2 c.c. of milk with 98 c.c. of water. The indications of the apparatus are said to agree with the results of analysis to 0·3 per cent of fatty matter.

Nutrition of the Lower Fungi by the Compounds of Carbon and Nitrogen.—Von Nägeli and O. Loew.—Liebig's assumption that the lower fungi can be nourished merely by albumenoid compounds has been already refuted by Pasteur. The authors find that they can assimilate nitrogen from all the amides and amines, the ammoniacal salts, and in some cases the nitrates. Free nitrogen and the nitrogen of cyanogen and the cyanides is not directly assimilated. Zygomycetes and schizomycetes assimilate nitric acid. Fungi can derive carbon even from certain antiseptics, such as alcohol, phenol, salicylic acid, and benzoic acid.

Vol. ix., No. 11.

Shot-ice in the Wiener Wald.—Dr. J. Breitenlohner.—An account of an incrustation of ice formed upon trees in the neighbourhood of Vienna, on Jan. 27, 1879.

Proportion of Ammonia in the Air and in Certain Waters.—A. Levy.—From the *Comptes Rendus*.

Researches on the Carbonic Acid in the Ground Air.—Prof. E. Wollny.—The proportion of carbonic acid as a rule rises and falls with the organic matter present in the earth.

Chemical Examination of the Arable Earth and the Sub-soil from Eight Places of the Black-Earth Region and the Adjacent District.—Prof. C. Schmidt.—Not adapted for abstraction.

Results of Manuring with Dicalcium Phosphate upon a Soil free from Humus.—H. Albert and Dr. Siegfried.—In such soils the plant prepares a solution of phosphoric acid from the neutral phosphate of lime by the action of its own roots. Manuring with dicalcium phosphate with or without potash improves the harvest both in quality and quantity. Potash and phosphoric acid increase the percentage of nitrogenous compounds.

The Acid of Milk.—E. Marchand.—The author ascribes the acid reaction of fresh milk drawn from healthy cows to the presence of 2 parts per thousand of lactic acid. For its observation he recommends the use of turmeric paper, or a tincture of logwood, Brazil wood, or cochineal. If litmus is used the caseine should be previously removed by the addition of 1½ to 2 vols. neutral alcohol at 90 per

cent, since caseine forms a light blue compound with litmus.

Decomposability of Nitrogenous Organic Manurial Matters.—Dr. A. Morgen.—A comparison between ground leather and ground horn, the former of which is much less easily rendered available for plant food. Ground leather is less suitable for manure and of lower value than horn powder.

The Albumenoids of Milk.—Dr. Danilewski and Dr. P. Badenhausen.—Already noticed.

Loss which Freshly-cut Grass Sustains from Moderate Rain.—Dr. A. Emmerling.—The mineral constituents are dissolved out in a much larger degree than the organic portions, and among the latter the non-nitrogenous extractive matters are removed more readily than the albumenoids.

Determination of Glycerin in Wines.—M. Raynaud.—In pure wines the separation of glycerin can be easily and accurately effected. In plastered samples the wine is concentrated to ⅛ of its volume, and treated with hydrofluosilicic acid, and then with alcohol in order to remove alkalies. Barium hydrate is then added in slight excess, the whole concentrated *in vacuo*, and the residue is exhausted with a mixture of alcohol and ether.

Vol. ix., No. 12.

Action of Water in Irrigation.—Dr. J. König.—This paper refers to irrigation with natural water. The action is said to consist in the supply of moisture, protection against the radiation of heat, the solution of plant food present in the soil, and the supply of fresh quantities of plant food.

The Absorption of Phosphoric Acid and Potash as Influenced by Chili Saltpetre.—H. Fiedler.—The absorption of phosphoric acid is promoted even by small doses of cubic nitre, whilst the absorption of potash is but little affected.

Turnip Sickness of Soils.—Prof. J. Kühn, Prof. v. Liebenberg, Prof. Marck, and Dr. G. Liebscher.—Turnip sickness is traced not to a deficiency of any ingredient of plant food, but to the multiplication of *Nematodæ*.

Researches on the Quantitative Determination of Proteine Nitrogen and the Separation of the Proteine Matters from other Nitrogenous Bodies Occurring in Plants.—Dr. A. Stutzer.—The author mixes the dissolved proteine compounds with perfectly neutral copper hydroxide free from alkali, and in this manner succeeds in precipitating the proteine compounds. Strongly diluted solution of copper sulphate is mixed with very dilute soda-lye till it reacts alkaline; the precipitate is thrown upon a large filter, washed quickly, the filter perforated, the precipitate is rinsed into a large bottle, which is filled up with cold water, and the hydrate washed by decantation till the supernatant liquid reacts perfectly neutral. The precipitate is then again placed upon a filter, let drain, pressed between blotting-paper till the greater part of the moisture is removed, and the pure blue copper hydroxide is rubbed up with water or alcohol.

The Use of the Lacto-butyrometer in Testing Milk.—Prof. G. C. Caldwell, MM. C. Jenssen, Friedländer, Schrodt, and Schmöger.—The results obtained by the use of this instrument sometimes agree with and sometimes differ from those given by direct analysis.

Philosophical Society of Glasgow (Chemical Section).—The Graham Medal, instituted in connection with this section for the encouragement of chemical research, and open to competition to all chemists, has, on the recommendation of Prof. Williamson, F.R.S., the adjudicator in the competition, been awarded to Mr. James Mactear, F.C.S., F.I.C., for a paper entitled "Some Researches on the Reactions involved in the Leblanc Process of Alkali Manufacture."

THE PURIFIED and GENERAL YEAST COMPANY (Limited).—Registered under the Companies' Acts, with limited liability.

CAPITAL £120,000 IN £1 SHARES,

Of which 38,000 Shares are taken by the Vendor, the remaining 82,000 Shares being now offered for Public Subscription, payable as follows:—1s. per Share on Application, 4s. on Allotment, and the balance when called up, but not more than 5s. per Share at one time, and at intervals between calls of at least one month. Where no Allotments are made the amount paid on application will be returned without any deduction. The expenses of the formation of the Company up to date of allotment will be borne by the Vendor.

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*THOMAS ELLIS, Esq., 80, Cornhill, London (the Vendor of the Patents).
**Will join the Board after the completion of the Assignment of the Patents mentioned below).*

BANKERS.—The Imperial Bank, Limited, Lothbury, E.C.
BROKER.—Henry Staples, Esq., 51, Threadneedle Street, E.C.
SOLICITORS.—Messrs. Mayhew, Salmon, and Whiting, 30, Great George Street, Westminster, S.W.
SECRETARY (pro. tem.).—Charles Akers, Esq.
Temporary Offices.—80, Cornhill, London, E.C.

ABRIDGED PROSPECTUS.

This Company is formed for the purpose of purchasing two Patents belonging to Mr. Thomas Ellis—one for purifying and extracting the bitter taste from Yeast; and the other, patented by Professor Charles Graham, D.Sc, the eminent Chemist, of University College, London, for stimulating and increasing the fermentative power of Yeast; and this Company proposes to work these Patents and to deal in purified and crude Yeasts.

By means of the joint processes, Brewers' Yeast is completely freed from the bitter taste of the hops, thoroughly purified, and its fermentative power and quickness greatly increased, and is thus converted into a substitute for the pure and powerful foreign Yeasts, but more especially German dried Yeasts, now imported into this country.

The Company's Purified and Stimulated Yeast has been tested by a large number of the principal London Bakers and Confectioners, including Messrs. Gunter and Co. (Berkeley Square), Birch, Stewart and Co., W. Buzzard, from whose Reports, given in full in the complete prospectus, it will be seen that, in their opinion, it is quite equal, if not superior, to any of the Foreign Yeasts.

The wholesale prices of the Foreign Yeasts vary from time to time, but are, as nearly as can be ascertained, equal to about £56 per ton in the cool months, rising, during the warm weather, to about £70 per ton, and even higher.

The Foreign Yeasts are re-sold by the Yeast merchants in this country to Bakers and Confectioners at from about ten to twelve pence per pound (equal to from £93 6s. 8d. to £112 per ton), and to cornchandlers and others, who retail them to the public at about one penny per ounce (equal to £149 6s. 8d. per ton).

The amount of Brewers' Yeast annually produced in this country is enormous, greatly exceeding the demand. The Company, will, therefore, always be able to obtain ample supplies of crude Brewers' Yeast at a very low price; and the cost of purifying and stimulating this Yeast is so small that, when prepared for the market, it can be sold, and with great profit, at so low a price as, it is believed, must defy competition.

The following Table shows the profits that may fairly be calculated on the Sale of Purified Yeast (wholesale) at any of the undermentioned prices:—

Cost of production of the Purified Yeast per ton.	Sold at per lb.	Equal to per ton.	Profit on each ton sold.	Equal to Per cent.
£ s. d.	d.	£ s. d.	£ s. d.	£ s. d.
14 0 0	3	28 0 0	14 0 0	100 0 0
,,	2¾	25 13 4	11 13 4	83 6 8
,,	2½	23 6 8	9 6 8	66 13 4
,,	2¼	21 0 0	7 0 0	50 0 0
,,	2	18 13 4	4 13 4	33 6 8
,,	1¾	16 6 8	2 6 8	16 13 4

The amount of the purchase money to be paid by the Company for the above-mentioned patents is £43,000, payable £38,000 in fully paid-up shares, and £5000 in cash.

The following documents can be seen at the Offices of the Solicitors of the Company:—The Agreement between the Company and Mr. T. Ellis; the Memorandum and Articles of Association; the Patents, and the Originals of the Reports, and of the Bakers and Confectioners above-mentioned.

Copies of the Prospectus, Reports, and Forms of Application can be obtained at the temporary offices of the Company, 80, Cornhill, London, E.C., or from the Solicitors, Bankers, or Broker of the Company.

IRISH HILL BAUXITE (Alum Clay).

The IRISH HILL MINING CO. are now, and always have been, the LARGEST PRODUCERS OF THIS CLAY, of Superior Quality, and supply the Manufacturers of Alum, Sulphate of Alumina, and Alum-Cake, of the United Kingdom, America, and the Continent, almost exclusively.

ANALYSIS BY JOHN PATTINSON, ESQ.

	Dried at 212° F.		
	Gertrude (extra qual.)	1st Quality.	2nd Quality.
Alumina	59·00	53·83	52·00
Peroxide of Iron	0·47	1·57	4·57
Silica	18·00	8·67	12·00
Titanic Acid		5·80	6·20
Lime, Magnesia, Potash, Soda, and Sulphuric Acid	0·23	0·83	1·14
Combined Water	22·30	29·27	24·00
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THE CHEMICAL NEWS.

VOL. XLIV. No. 1131.

A DIFFERENTIAL METHOD OF SPECIFIC GRAVITY DETERMINATION.

By W. DITTMAR.

To determine the difference in specific gravity between two liquids, the most obvious method is to determine the specific gravities themselves; and in most cases a convenient mode of doing this is to immerse a tared glass plunger successively in water Liquid I. and Liquid II., and ascertain in each case the loss of weight which the plunger suffers. But supposing the two liquids to be (say solutions) of the same kind, and of very nearly the same density (and this is the only case which I here propose to deal with), the desired difference can be obtained directly, and with a far higher degree of exactitude, by weighing a known volume of the one liquid within the other. The apparatus required are as follows:—

(1.) A cylindrical specific gravity bottle, provided with a narrowly perforated glass stopper, and a hook (above or below) for suspending it from the balance by a fine platinum wire.

(2.) A cylinder large enough to float the bottle, supposing it to be suspended in a mass of liquid within the cylinder.

(3.) A balance, so arranged that things can be suspended *below* the pans, and when thus suspended are at a convenient working height.

Modus operandi.—After having ascertained (once for ever) the capacity of the bottle for water, charge it with liquid I., suspend it from the balance within a mass of the same liquid, and ascertain its apparent weight (p' grms.)

Then repeat the experiment with liquid II. *inside*, and note down the result p''.

If the capacity of the bottle is $= v$ fluid grms., we obviously have $v(s''-s') = p''-p'$, or—

$$s''-s' = \frac{p''-p'}{v}.$$

In both weighings we must take care to give the inner liquid time to assume the temperature of the outer, *i.e.*, to postpone the final weighing until the weight has become constant.

One of the advantages of this method is that the result is relatively independent of errors in temperature. Supposing the bottle to be filled *successively* with the two liquids at intentionally the same temperature, and weighed in the ordinary way; then if the temperature of liquid II. (by error) is by (Δt), say too high, the error in weight is $-v(\Delta t)s''k$, and the error in specific gravity is $(\Delta t)s''k$, where k means the coefficient of expansion of the liquid. In our method the corresponding error (Δs) is equal to only $k(\Delta t)(s'-s'')$, *i.e.*, far less. For $\frac{s'-s''}{s''} = 0{\cdot}01$, for instance, it is only 1-100th of the error of the ordinary method.

In conclusion, I will quote a few experiments which I made for testing the method for its practical workability.

Expt. (1.)—I. = water; II. = centinormal hydrochloric acid, *i.e.*, an acid of about 0·036 per cent.

I. inside and I. outside; $p' = 5{\cdot}343$
II. ,, I. ,, $p'' = 5{\cdot}347$

$v = 23{\cdot}43$; $\therefore s'' = s' = \frac{4}{23{,}400} = 0{\cdot}00017$

The uncertainty in $p''-p'$ is about $\pm$ 1 m.grm.; $\therefore$ the uncertainty in the result is about 4 units in the 5th place.

Expt. (2.)—I. = water; II. = solution of tannin of sp. gr. 1·00336 at 21·6, as determined by a glass plunger of about 30 c.c. volume.

I. inside and I. outside; $t = 20{\cdot}4°$; $p' = 7{\cdot}267$
II. ,, I. ,, ,, $p'' = 7{\cdot}386$

The whole system left to itself for a night, next morning $t = 17{\cdot}3°$; $p'' = 7{\cdot}386$; *i.e.*, the same as before, which shows that the existing difference in the expansion, and the diffusion going on for about fourteen hours failed to tell upon the result. $v = 32{\cdot}8$; $\therefore s''-s' = 0{\cdot}00361 \pm 0{\cdot}00003$. The difference between this result and the excess over unity in the specific gravity 1·00336, as determined in the ordinary way (as far as it indicates errors), must be charged against the latter method.

Expt. (3.)—$v = 6{\cdot}3085$; 96 per cent alcohol, both inside and outside; $p = 4{\cdot}208$. Now a small quantity of water was mixed with the outer liquid, so that, by calculation, the percentage of alcohol there fell by 0·13 per cent. The bottle rose, and, after establishment of equilibrium of temperature, p'' was $= 4{\cdot}2045$. In this case, of course, the *outer* volume of the bottle must be substituted for v. The volume of the body of the bottle was estimated at about 1·67, whence v, corrected, $= 7{\cdot}98$, say 8; whence—

$$s''-s' = -0{\cdot}00044 \pm \text{about } 0{\cdot}0001.$$

$s''-s'$ by Fownes's table $= 0{\cdot}0004$.

The new method is susceptible of a number of useful applications, of which the following occur to me just now:—

(1.) Preparation of large supplies of standard solutions, supposing a small quantity of the correct solution to be at hand.

(2.) Determination of the specific gravities of waters in general, and sea waters in particular, as of dilute solutions generally.

(3.) Execution of *Hammer's* process for the determination of tannin in infusions of oak-bark, &c. (See "Fresenius's Quantitative Analysis," p. 673 of Ed. VI.) For this purpose, as I may note in passing, the method was originally invented. Experiments in this particular direction are in progress.

(4.) The examination of *butter* fat by Mr. Bell's method.

Anderson's College, Glasgow,
July 18, 1881.

ON A CURIOUS ACTINIC PHENOMENON.

By J. CAWLEY, A.R.S.M.

ON reading a communication from Dr. Phipson upon the subject designated above (CHEMICAL NEWS, vol. xliii., p. 283), I was much struck with the great discrepancy between his results and those obtained by myself in experimenting with sulphide of zinc pigments. I should be disinclined to question his results but for the high probability that I, having been engaged in the manufacture of such pigments for several years, have made *hundreds* of experiments in connection with them where Dr. Phipson has made *one*. It will perhaps make the following remarks much more readily intelligible if I give a brief description of the method generally adopted in manufacturing sulphide of zinc containing pigments.

A solution of a zinc salt, *carefully freed* from iron, manganese, &c., is precipitated by means of a solution of an alkaline or alkaline-earthy sulphide. The resulting precipitate is dried, and ignited at a full red heat, and drawn into water, and afterwards levigated, filtered, dried, and ground.

Now, Dr. Phipson says that the sample analysed by him was *white*, but my experience has taught me that such a pigment containing over 2 per cent of protoxide of iron would be more nearly *black*. And I am really puzzled to understand how barium sulphide and protoxide of iron could exist side by side in *prolonged* contact with water

without any blackening taking place. And I am still more deeply puzzled to know how barium sulphide could *occur* in the finished pigment. In the process of manufacture care is *always* taken to have a slight excess of zinc salt. If barium sulphide were in even slight excess much trouble would ensue, and a pigment of *maximum* whiteness could not be obtained. Moreover, in the process of ignition—or, as it is improperly called, calcination—notable quantities of zinc sulphates, and in some cases chloride of zinc, are formed, and these on drawing the pigment into water, pass into solution. Now I must confess that I cannot imagine how barium sulphide can remain in *prolonged* contact with a hot solution of a zinc salt without being destroyed.

Dr. Phipson is of opinion that the discolouration is connected with the presence of barium sulphide in the pigment, but I have found that the pigment *may* be just as sensitive to light if no barium salt be used. So far, too, from the dark substance being soluble in acetic acid, I have found that it is readily formed in the presence of that acid. Under a given set of atmospheric conditions I find that a sheet of glass exerts no *sensible* protective action, while Dr. Phipson claims that such protection was complete.

In conclusion, let me say that I have made a large number of experiments on this interesting subject, and I shall be glad to give a brief account of them and the inferences drawn therefrom if our Editor will afford me the necessary space.

Newark, N.J., U.S.A., July 6, 1881.

ON SEWAGE IN OYSTERS.*

By CHARLES A. CAMERON, M.D., M.K.Q.C.P.I.

Large numbers of oysters collected by dredges off the coast of the county of Wexford are laid down in "beds" on the northern shore of the Bay of Dublin. When fully developed in these "Clontarf beds" they are removed for consumption to Dublin and other places. Formerly the Clontarf oysters were thriving molluscs, but during late years they have not done well, and great numbers of them die shortly after their translation from their native habitat.

Owing to the recent construction of many large sewers, the contents of which are discharged into the northern side of Dublin Bay, and also owing to the rapid development of the water-closet system in Dublin and its suburbs, the water of the Bay is yearly becoming more polluted with excrementitious and other offensive matters. These obnoxious substances are thrown up on the fore-shores of the Bay. The river Liffey, which is the chief carrier of filth to the Bay, is steadily becoming more and more polluted. It is only a generation ago when mullets and other edible fishes were numerous in the river, where now they are rarely seen. Near the estuary there were numerous beds of oysters, which have become extinct, partly owing to their sites being now the "berths" of ships, but also owing apparently to the great pollution of the river.

An examination of some oysters taken from Clontarf and of the water which covered them has afforded rather startling results. The oysters—a large and coarse variety—were taken from a place where the tide covers them to a height of about ten feet, and which during low water is nearly dry. In most of the oysters the brine had no peculiar odour, but in a rather large proportion there was a very slight, but distinctly fœtid odour, whilst in a few cases there was a strong and unmistakable odour of sewage. Examined microscopically the liquid in the oysters which had a fœtid odour was found to swarm with micrococci and other low organisms similar to those usually present in sewage.

* From the Report on Public Heath, July, 1881. Reprinted from the *Dublin Journal of Medical Science*.

The sea-water taken at the oyster beds when the tide was fully in was subjected to chemical analysis, and the following were the results arrived at:—

One imperial gallon (70,0000 grs. weight) contained, in addition to water—

	Grains.
*Volatile matter at a red heat	303·000
Fixed substances at ,, ...	2110·000
Total solid matters	2413·000
*Yielding—Albumenoid ammonia ..	0·009
Saline ammonia	0·010

One gallon of the water taken, when the tide was fully out, from little pools containing oysters, was found to contain the following, exclusive of pure water—

	Grains.
*Organic and volatile matters	242·000
Fixed mineral substances	1406·000
Total solid matters	1648·000
*Yielding—Albumenoid ammonia ..	0·090
Saline ammonia	0·300

Thus it will be seen that the albumenoid ammonia was ten times, and the saline ammonia thirty times, more abundant in the water taken when the tide was out, clearly proving that it was in great part composed of sewage.

The large amount of solids in the "low water" may be accounted for by the evaporation of the surface water—the weather at the time being warm—concentrating the saline matter in the remaining water. The water taken when the tide was out had a decidedly sewage odour, and teemed with low forms of life.

Marine crustacean and molluscous animals are amongst the most active scavengers of our coast; they devour not only animalcules, but also particles of dead animals and vegetable matter contained in the water. In the case of crustaceans, this decomposing organic matter becomes reorganised into living tissue, and, therefore, these animals furnish wholesome food to man. Lobsters and crabs are also always cooked before being eaten. Oysters, cockles, mussels, and other lamellibranchiate molluscs are often eaten uncooked, and their shells enclose a liquid which is more frequently drank uncooked than cooked. Although oysters when deserted by the tide instinctively keep their valves closed, they do not invariably do so, and, therefore, at low water, sewage trickling down the shore is likely to find its way into the interior of the open oysters. Now, if potable water and milk be vehicles in which it is possible that the germs of typhoid fever may exist, why may they not be sometimes present in the so-called juice of an oyster or cockle? Anyone may satisfy himself that sewage is constantly discharging over fore-shores, in which various edible molluscs have their abiding place; and it is in the highest degree improbable that animals can always resist successfully the entry of polluted brackish water into their calcareous dwellings. Under all the circumstances we confess that we prefer to eat oysters taken from the lonely shores of Clare and Kerry, rather than from the sewage-polluted estuaries of rivers like the Liffey and the Thames. It may be that the illness which so many persons have experienced after swallowing oysters, believed to have been stale, was really due to the presence of sewage matter in the juice of the molluscs.

Analysis of Milk.—Drs. N. Gerber, P. Radenhausen, H. Vogel, and L. Janke.—It is recommended not to measure, but to weigh the milk for analysis. For the determination of the dry matter, the writers prefer to coagulate the milk with alcohol or acetic acid, and dry without the addition of sand.—*Biedermann's Centralblatt für Agrikultur Chemie*, ix., 12.

INDIGO, AND ITS ARTIFICIAL PRODUCTION.*

By H. E. ROSCOE, LL.D., F.R.S., &c.
President of the Chemical Society.

More than eleven years ago the speaker had the pleasure of bringing before this audience a discovery in synthetic chemistry of great interest and importance, viz., that of the artificial production of alizarin, the colouring substance of madder. To-day it is his privilege to point out the attainment of another equally striking case of synthesis, viz., the artificial formation of indigo. In this last instance, as in the former case, the world is indebted to German science, although to different individuals, for these interesting results, the synthesis of indigo having been achieved by Professor Adolf Baeyer, the worthy successor of the illustrious Liebig in the University of Munich. Here, then, we have another proof of the fact that the study of the most intricate problems of organic chemistry, and those which appear to many to be furthest removed from any practical application, are in reality capable of yielding results having an absolute value measured by hundreds of thousands of pounds.

In proof of this assertion, it is only necessary to mention that the value of the indigo imported into this country in the year 1879 reached the enormous sum of close on two millions sterling, whilst the total production of the world is assessed at twice that amount; so that if, as is certainly not impossible, artificial indigo can be prepared at a price which will compete with the native product, a wide field is indeed open to its manufacturers.

Indigo, as is well known, is a colouring-matter which has attracted attention from very early times. Cloth dyed with indigo has been found in the old Egyptian tombs. The method of preparing and using this colour is accurately described by both Pliny and Dioscorides, and the early inhabitants of these islands were well acquainted with indigo, which they obtained from the European indigo plant, *Isatis tinctoria*, the woad plant, or pastel. With this they dyed their garments and painted their skins. After the discovery of the passage to India by the Cape of Good Hope, the Eastern indigo, derived from various species of *Indigofera*, gradually displaced woad, as containing more of the colouring-matter. But this was not accomplished without great opposition from the European growers of woad; and severe enactments were promulgated against the introduction of the foreign colouring-matter, an edict condemning to death persons "who used that pernicious drug called devil's food" being issued by Henry the Fourth, of France. The chief source of Indian indigo is the *Indigofera tinctoria*, an herbaceous plant raised from seed which is sown in either spring or autumn The plant grows with a single stalk to a height of about 3 feet 6 inches, and about the thickness of a finger. It is usually cut for the first time in June or July, and a second or even a third cutting obtained later in the year. The value of the crop depends on the number of leaves which the plant puts forth, as it is in the leaves that the colouring principle is chiefly contained. Both the preparation of the colouring-matter from the plant, and its employment as a dye or as a paint, are carried on at the present day exactly as they have been for ages past. The description of the processes given by Dioscorides and Pliny tally exactly with the crude mode of manufacture carried on in Bengal at the present day as follows:—

"The Bengal indigo factories usually contain two rows of vats, the bottom of one row being level with the top of the other. Each series numbers from fifteen to twenty, and each vat is about 7 yards square and 3 feet deep; they are built of brickwork lined with stone or cement. About a hundred bundles of the cut indigo plants are placed in each vat in rows, and pressed down with heavy pieces of wood; this is essential to the success of the operation. Water is then run in so as to completely submerge the plants, when a fermentation quickly ensues, which lasts from nine to fourteen hours, according to the temperature of the atmosphere. From time to time a small quantity of the liquor is taken from the bottom of the vat to see how the operation is proceeding. If the liquor has a pale yellow hue the product obtained from it will be far richer in quality, but not so abundant as if it had a golden yellow appearance. The liquor is then run off into the lower vats, into which men enter and agitate it by means of bats or oars, or else mechanically by means of a dash-wheel, each vat requiring seventeen or eighteen workpeople, who are kept employed for three or four hours. During the operation, the yellow liquor assumes a greenish hue, and the indigo separates in flakes. The liquor is then allowed to stand for an hour, and the blue pulpy indigo is run into a separate vessel, after which it is pumped up into a pan and boiled, in order to prevent a second fermentation, which would spoil the product by giving rise to a brown matter. The whole is then left to stand for twenty hours, when it is again boiled for three or four hours, after which it is run on to large filters, which are placed over vats of stonework about 7 yards long, 2 yards wide, and 1 yard deep. The filters are made by placing bamboo canes across the vats, covering these with bass mats, and over all stretching strong canvas. The greater part of the indigo remains under the form of a dark blue or nearly black paste, which is introduced into small wooden frames having holes at the bottom and lined with strong canvas. A piece of canvas is then placed on the top of the frame, a perforated wooden cover, which fits into the box, put over it, and the whole submitted to a gradual pressure. When as much of the water as possible has been squeezed out the covers are removed, and the indigo allowed to dry slowly in large drying sheds, from which light is carefully excluded. When dry, it is ready for the market. Each vat yields from 36 to 50 lbs. of indigo."*

The same process carried out in the times of the Greeks is thus described by Dioscorides: "Indigo used in dyeing is a purple coloured froth formed at the top of the boiler; this is collected and dried by the manufacturer: that possessing a blue tint and being brittle is esteemed the most."

The identity of the blue colouring-matter of woad and that of the Bengal plant was proved by Hellot, and by Planer and Trommsdorff at the end of the last century. These latter chemists showed that the blue colour of the woad can be sublimed, and thus obtained in the pure state, a fact which was first mentioned in the case of indigo by O'Brien, in 1789, in his treatise on calico-printing. Indigo thus purified is termed indigotin. It has been analysed by various chemists, who ascertained that its composition may be most simply expressed by the formula C_8H_5NO.

Indigo is a blue powder, insoluble in water, alkalies, alcohol, and most common liquids. In order to employ it as a dyeing agent it must be obtained in a form in which it can be fixed or firmly held on to the fibres of the cloth. This is always effected by virtue of a property possessed by indigo-blue of combining with hydrogen to form a colourless body, soluble in alkalies known as indigo-white, or reduced indigo, of which the simplest formula is C_8H_6NO. This substance rapidly absorbs oxygen from the air and passes into the blue insoluble indigo, which, being held in the fibre of the cloth, imparts to it a permanent blue dye. This reduction to white indigo may be effected in various ways. The old cold vat, or blue-dip vats as they are termed, consist of a mixture of indigo, slacked lime, and green vitriol. The latter salt reduces the indigo, and the white indigo dissolves in the lime water. This process of indigo dyeing is both expensive and troublesome, owing to loss of indigo and formation of gypsum, so that many plans have been proposed to remedy these evils.

Concerning the origin of indigo in the leaves of the *Indigofera*, various and contradictory views have been

* A Paper read before the Royal Institution of Great Britain, Friday, May 27, 1881.

* Crace-Calvert.

held. Some have supposed that blue indigo exists ready formed in the plant; others, that white indigo is present, which on exposure to air is converted into indigo-blue. Schunck has, however, proved beyond doubt that the woad plant (*Isatis tinctoria*), the *Indigofera tinctoria* of India, and the Chinese and Japanese indigo plant (*Polygonum tinctorium*) contain neither indigo-blue nor white indigo ready formed. It is now known that by careful treatment the leaves of all these indigo-yielding plants can be shown to contain a colourless principle termed indican, and that this easily decomposes, yielding a sugar-like body and indigo-blue. That white indigo is not present in the leaves is proved by the fact that this compound requires an alkali to be present in order to bring it into solution, whereas the sap of plants is always acid. The decomposition is represented by Schunck as follows:—

$$\underset{\text{Indican.}}{C_{26}H_{31}NO_{17}} + 2H_2O = \underset{\text{Indigotin.}}{C_8H_5NO} + 3\underset{\text{Indiglucin.}}{C_6H_{10}O_6}.$$

So readily does this change from indican to indigo take place, that bruising the leaf or exposing it to great cold is sufficient to produce a blue stain. Even after mere immersion in cold alcohol or ether, when the chlorophyll has been removed, the leaves appear blue, and this has been taken to show the pre-existence of indigo in the plant. But these appearances are deceptive, for Schunck has proved that if boiling alcohol or ether be used, the whole of the colour-producing body as well as the chlorophyll is removed, the leaves retaining only a faint yellow tinge, whilst the alcoholic extract contains no indigo-blue, but on adding an acid to this liquid the indican is decomposed and indigo-blue is formed.

Passing now to the more immediate subject of his discourse, the speaker again reminded his hearers that indigo was the second natural colouring-matter which has been artificially prepared; alizarin, the colouring matter of the madder-root being the first. As a rule, the simpler problems of synthetic chemistry are those to which solutions are the soonest found, and these instances form no exception to the rule. The synthetic production of indigo is a more difficult matter than the artificial formation of alizarin, and hence the speaker did not apologise for leading up to the complex through the more simple phenomenon.

When the ingenious Japanese workman who had never seen a watch had one given to him with an order to make a duplicate, he took the only sensible course open to him, and carefully pulled the watch to pieces, to see how the various parts were connected together. Having once ascertained this, his task was a comparatively easy one, for he then had only to make the separate parts, and fit them together, and he thus succeeded so well in imitating the real article that no one could tell the difference. So it is with the chemist; until he knows how the compound is built up, that is, until he has ascertained its constitution, any attempt at synthesis is more like groping in the dark than like shaping the course by well-known landmarks into harbour.

In the case of alizarin it was comparatively easy to reduce it to its simplest terms, and to show that the backbone of this colouring-matter is anthracene, $C_{14}H_{10}$, a hydrocarbon found in coal-tar. This fact being ascertained, the next step was the further process of clothing the hydrocarbon by adding four atoms of oxygen and subtracting the two atoms of hydrogen present in excess, and this was soon successfully accomplished, so that now, as we know, artificial alizarin has excluded the natural colouring-matter altogether.

$$\underset{\text{Anthracen.}}{C_{14}H_{10}} \qquad \underset{\text{Alizarin.}}{C_{14}H_6O_2(OH)_2}.$$

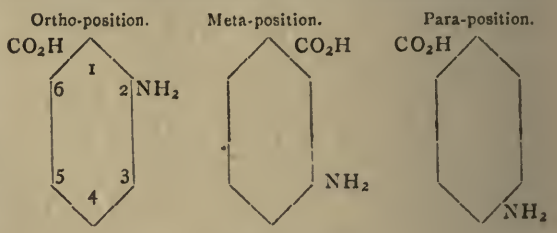
What now was the first step gained in our knowledge concerning the constitution of indigo, of which the simplest formula is C_8H_5NO?

Step No. 1.—This was made so long ago as 1840, when Fritsche proved that aniline, $C_6H_5NH_2$, can be obtained from indigo. The name for this now well-known substance is indeed derived from the Portuguese "anil," a word used to designate the blue colour from indigo. This result of Fritsche's is of great importance, as showing that indigo is built up from the well-known benzene ring, C_6H_6, the skeleton of all the aromatic compounds, and, moreover, that it contains an amido- group.

Step No. 2 was also made by Fritsche in the following year, when, by boiling indigo with soda and manganese dioxide, he obtained ortho-amido-benzoic acid, or, as he then termed it, anthranilic acid. The following is the reaction which here occurs:—

$$\underset{\text{Indigo.}}{C_8H_5NO} + O + 2H_2O = \underset{\text{Ortho-amido-benzoic acid.}}{C_7H_5NH_2O_2} + CH_2O_2.^*$$

What light does this fact shed upon the constitution of indigo? It shows (1) that one of the eight atoms of carbon in indigo can be readily separated from the rest; (2) that the carboxyl and the amido- group are in neighbouring positions in the benzene ring, viz., 1 and 2. For we have three isomeric acids of the following composition:—



(To be continued.)

ON THE CONDUCT OF FINELY-DIVIDED IRON TOWARDS NITROGEN.

By IRA REMSEN.

A recent writer† states that the method of Lassaigne for the detection of nitrogen in bodies containing carbon is not applicable to compounds in which sulphur is present. He claims that the sulphur gives rise to the formation of sulphocyanide, and that this is overlooked, as the solutions are strongly acid. A list of compounds is given in which nitrogen cannot be detected. It includes taurine, sulphourea, sulphocyanide of potassium, and the "amides of the sulphonic acids." In such cases it is recommended to fuse the bodies with sodium and pure iron, instead of sodium alone, as is customary. The sulphur forms sulphide of iron, and the nitrogen forms the cyanide, and can easily be detected.

As I have repeatedly used the ordinary method for the detection of nitrogen in compounds containing sulphur, and have in some cases relied upon the results reached, I undertook an examination of the subject thus opened, and I have been led to conclusions directly opposed to those of the writer referred to. At the same time certain interesting observations have been made on the conduct of pure iron, reduced by hydrogen, towards nitrogen.

As regards the statement that the method of Lassaigne is not applicable to compounds containing sulphur, I am prepared to give this an unqualified denial. I have examined every one of the substances mentioned by the writer, with the exception of cystine, and have in each case, without the slightest difficulty, obtained the precipitate of Prussian blue. I have also examined a large number of other substances, and have never experienced difficulty in getting the result looked for. Then, further, the fact that sulphocyanide of sodium or potassium itself breaks up under the influence of heat in the presence of an alkaline metal shows clearly that, even if this salt is

* Böttinger, *Deut. Chem. Ges.*, 1877, i., 269.
† *Ber. der Deut. Chem. Gesell.*, xii., 2316.

formed as is claimed and as is probable, the detection of the nitrogen cannot be interfered with by the presence of sulphur.

Having shown beyond a doubt that the conclusion I had drawn with reference to a certain compound, that it contained no nitrogen, is correct, I nevertheless fused a small specimen of this compound with sodium and iron by hydrogen, and was astonished to find that, on extracting the fused mass with water, filtering, and then adding successively ferric and ferrous salts and hydrochloric acid, the blue precipitate revealing the presency of nitrogen was distinctly formed. I repeated the experiments a number of times, but always with practically the same result. In every case the blue precipitate was formed, though in some cases it seemed to be formed in larger quantity than in others. The variations in quantity were, however, not striking.

I now took other non-nitrogenous organic substances than the one which was in question and tested these. The two purest specimens in this laboratory at the time were one of the double tartrate of potassium and sodium which had been re-crystallised a large number of times, and one of cane-sugar which had been repeatedly re-crystallised from alcohol. These two specimens may certainly be regarded as in the strictest sense chemically pure. Both of these substances gave the reaction for nitrogen distinctly. Of all the substances experimented upon, the pure double tartrate seemed to be best adapted to the purpose, and in continuing the experiments I have since always employed this particular pure specimen to furnish the carbon.

The question naturally suggests itself, whence comes the nitrogen in these reactions? I at first suspected the iron by hydrogen, and my suspicions were increased when, on enquiring into the history of the specimen used, I found that it had been made from ferric hydroxide precipitated by ammonia. To be sure the hydroxide had been washed with the greatest care, and had afterward of course been ignited in a current of hydrogen, and it did not seem probable that ammonia or any compound of ammonia and iron could be retained; but still, there was the nitrogen, and it appeared at least possible that it was actually contained in the iron. To test this point ferric hydroxide was precipitated from a solution of the pure chloride by means of sodium carbonate, and washed out until no test for sodium could be obtained. This precipitate was then divided into two parts, one of which was dried at once, and the other boiled for some hours with a solution of ammonium carbonate and ammonia. The latter was then washed out, no special precautions being taken to remove all the ammonium salts, and afterwards dried. Both specimens were separately reduced in a current of purified and dried hydrogen. *Both gave the test for nitrogen*, and indeed the one from which all ammonium compounds had been carefully excluded seemed to give the test better than the other.

Another specimen of iron by hydrogen, which has been in the collection of chemicals of this laboratory for five years, and which does not take fire by contact with the air, failed to give the nitrogen test. This led me to think that possibly the nitrogen is not contained in the iron, but is absorbed from the air, and that the power to absorb nitrogen in this way is connected with the active condition of the iron. Both the specimens above referred to, which in the active condition readily and invariably gave the test for nitrogen, were allowed to stand for a short time in contact with the air, and were then again tested. *Neither gave the reaction.* The same experiment was peformed with the specimen of iron by hydrogen first used, and which had been preserved under ether. A portion of this was allowed to stand over-night exposed to the air, and then gave no indication of the presence of nitrogen. These results make it appear extremely probable that the nitrogen detected when active iron is used is really absorbed from the air. But if this is so, then more thorough contact of the heated reagents with the air ought to increase the quantity of cyanide formed. All the experiments thus far mentioned were performed in test-tubes, and of course very little air came in contact with the substance at the bottom of the tube. On heating the necessary mixture in a crucible, however, violent combustion of the sodium took place, and no reaction for nitrogen was obtained. To prevent this combustion, a mixture of iron by hydrogen, double tartrate of sodium and potassium, and metallic sodium was placed in a hard glass tube, and dry hydrogen passed through while gentle heat was applied to drive off water. Then nitrogen was passed slowly over the mixture, while at the same time it was heated to redness. This process was continued for about ten minutes, when, on allowing the tube to cool, the contents were extracted with water, filtered, and treated in the usual manner. To my surprise, *a very large precipitate of Prussian blue was formed*, much larger in proportion than in any previous experiment. The result is so striking that the experiment is well adapted to serve the purpose of a lecture experiment, illustrating the formation of cyanogen from the nitrogen of the air. There can be no doubt that the nitrogen is really absorbed from the air. The quantity of the precipitate obtained in the last experiment was so great as to exclude the supposition that the nitrogen could have been present in the substances used. Then, further, the fact that the active iron, which readily gives the test for nitrogen, does not give the test after it has been exposed to the air and become oxidised, is a clear indication that the active condition of the iron is an important factor in the process, and that the nitrogen cannot be in combination with the iron. For if it were, it is difficult to understand how the spontaneous oxidation of the iron could remove it. The heat evolved can scarcely be sufficient to decompose any nitrogen compound present, for the iron is heated to a much higher temperature in the course of its preparation, and the possible nitrogen compound must have been decomposed by this first application of heat.

I have thus far performed no quantitative experiments, and there are obvious difficulties in the way of making these exact. As it is intended soon to continue the experiments, however, an attempt will be made to determine as near as possible how much nitrogen can be taken up and combined chemically by given weights of the reagents. Some other points of interest will also be taken up. Thus, in attempting to exclude the air from the vessels in which the reactions took place, hydrogen was used, and the nitrogen test was not obtained. But on testing a nitrogenous substance (hippuric acid) in the same way, very little evidence of nitrogen was obtained. It would hence appear that that the test cannot be applied in an atmosphere of hydrogen, or that the cyanide is decomposed when heated in hydrogen. On the other hand, Marchand* has stated that hydrogen does not interfere with the application of the test.

As a result of the experiments described in this paper, it may be stated with confidence that *when iron by hydrogen and certain non-nitrogenous organic substances are heated together with metallic sodium in an atmosphere of nitrogen a cyanide is readily formed.* The action is, of course, similar to that which takes place in blast-furnaces, and which gives rise to the formation of cyanide of potassium. In the latter case, the carbonate of potassium from the burning of the fuel furnishes the potassium. Nitrogen is always present in large quantity, and the iron is constantly passing from the state of oxide to that of the metal.

Marchand some years ago showed† that steel when heated with carbon and potassium can take up nitrogen. It had been previously stated by Schaufhäutl‡ that steel always contains nitrogen. The experiments of Marchand made this statement appear improbable, though they did not disprove it. Indeed, later a discussion arose in France on the same subject. Fremy claimed that not only is

* *Journ. Prakt. Chem.*, xlix., 355.
† *Loc. cit.*
‡ *Ibid.*, xix., 409.

nitrogen always present in steel, but it is the essential element of the steel. This discussion did not at the time lead to a satisfactory conclusion. Quite recently Müller* has found nitrogen in not inconsiderable quantity in the gases extracted from Bessemer steel by boring, but thus far he has not been able to determine whether the nitrogen is simply enclosed in the pores of the steel or is chemically combined with it.

I have made a number of experiments with Bessemer steel and with other forms of iron, and have obtained results in accordance with those already on record. It seems possible that as regards steel the nitrogen detected may be partly absorbed from the air and partly present in combination with the iron, though it would be difficult to prove the correctness of this supposition.—*American Chemical Journal.*

May, 1881.

THE OWENS COLLEGE COURSE OF TECHNOLOGICAL CHEMISTRY.

Most of our readers are aware that the Owens College is now duly constituted by Royal Charter a college of the New Victoria University. This University has the power to grant degrees to persons who have completed their studies in any of its colleges, and possesses many features upon which we cannot look without a feeling of lively satisfaction. It is not, like the University of London, a mere examining body. It contemplates actual research in the various sciences, and we have already had the satisfaction of seeing in *Liebig's Annalen* an article headed "Chemical Researches from the Laboratory of the Victoria University, Manchester." We find that in every department of science where such an arrangement is possible there is a practical course—"practicum" as it is called in the German Universities—and there are special facilities for students desirous of pursuing original investigations. There is also a most valuable latitude in the subjects to be studied. Thus, in the Faculty of Science the student during his second and third year has the choice of four distinct courses—the mathematical, the engineering, the experimental science course, and the biological.

We are particularly interested in the course of technological chemistry, which extends over four years, and which is very similar to the courses at the Polytechnic Schools of Aix-la-Chapelle, Zurich, &c., which have had such a powerful influence in promoting chemical industry in their respective countries. The first year's course consists of chemistry lectures, junior and tutorial classes, laboratory work two days weekly, and class work in analytical chemistry; pure mathematics, experimental mechanics *or* geology; the French *or* German language.

In the second year there are chemical lectures (junior, senior, and tutorial classes): laboratory work three days weekly; technological chemistry; experimental physics *or* mineralogy; German *or* French language. In the third year the course embraces chemistry lectures (senior and tutorial classes); lectures on organic chemistry and on chemical philosophy; laboratory work three days weekly; technological chemistry; and work in the physical laboratory, *or* in practical mineralogy, one day weekly.

In the fourth year there are lectures on organic chemistry and technological chemistry; four days' laboratory work, and the chemistry of colouring matters, dyeing and printing. In all four years there is also instruction in mechanical drawing.

The instructions in technological chemistry are conducted by Mr. Watson Smith, F.C.S., and embrace for the first year the sulphuric acid and alkali manufactures; bleaching-powder and liquor, potassium chlorate, and utilisation of burnt copper pyrites. The second course deals with the destructive distillation of wood and the products obtained; the destructive distillation of coal, the gas manufacture, ammonia and its salts, tar products, &c. In the third course will be explained the manufacture of pure tar products and derivatives; carbon bisulphide; turpentine, rosin, and rosin oils, and, if time allows, bleaching.

We are happy to learn that the students will through the courtesy of several manufacturers have the privilege of inspecting various chemical works where the processes described in the lectures may be seen in actual practical operation.

If this programme is ably carried out, the relative position of our chemical manufactures must before long show a marked improvement. But why could not the necessity of such arrangements be seen a quarter of a century ago?

* *Ber. der Deut. Chem. Gesell.*, xiv., 1.

PROCEEDINGS OF SOCIETIES.

AMERICAN CHEMICAL SOCIETY.*

June 3, 1881.

Dr. Albert R. Leeds, Vice-President, in the Chair.

The regular business of the Society was transacted, and Mr. A. P. Halloch, Ph.B., was duly elected a member of the Society.

After which the first paper of the evening, by Dr. Chas. A. Doremus, was read "*On the Analysis of Elephant's Milk.*" One sample of this milk gave 66·693 per cent of water; 33·303 per cent of solids; 22·070 per cent of fats; 11·233 per cent of solids not fats; 3·212 per cent of casein; 7·392 per cent of sugar; and 0·629 per cent of ash.

In discussing this paper, Dr. Leeds remarked that the ash closely approximated to that of human milk. He also further remarked that the difficulty of evaporating the milk, experienced by Dr. Doremus, could be overcome by using 10 c.c. of milk upon 30 c.c. of ignited sand, and this procedure caused no charring, the large excess of sand preventing the milk from touching the sides of the dish.

Dr. E. R. Squibb having taken the Chair, Dr. Leeds then read a paper "*Upon the Adulteration of Food, Drink, and Drugs, from the Chemist's Standpoint; and upon the Attitude of Chemists in the Matter of Appointment of Government Analysts.*" The subject of adulteration had not received that amount of attention from the chemists which its nature and amount, as at present practised in the United States, properly demanded. And in neglecting to assume control of the investigation of the subject, and of the information and education of the public mind as to the actual facts, they had left the field in the possession of scientific demagogues and pseudo-chemists, who, for the past four years, had been sending out through the daily press an unlimited amount of sensational literature, either in part or altogether false. The investigations as to the facts had been mainly fragmentary and sporadic in their character, instituted from time to time by various Boards of Health, but without much outcome in the arrest and prosecution of offenders. But this period of education had now gone by, and the time had come when the various States were about to pass laws upon adulteration. Some laws had been already enacted, and grave blunders had been committed. The experience in England had shown how difficult it was to secure wise and efficient legislation, and it was very important for chemists in America to avail themselves of that experience, and to control and shape the laws under consideration in the various State legislatures. Moreover, the duties of a public analyst required peculiar training and an accurate knowledge of certain topics not ordinarily studied by chemists. Finally, the analysts could not properly perform their labours

* Communicated by Arthur H. Elliott, Ph.B., F.C.S., Recording Secretary.

without the aid of suitably qualified inspectors, and as yet these two professions did not exist in the country, and would have to be in a sense created. Dr. Leeds who had been commissioned by the State of New Jersey to investigate the facts concerning adulteration, as a basis for future State legislation, then gave brief *résumé* of the results of his labours up to date. He had analysed a very large number of samples, and without claiming that the facts were universally true for the whole country, yet the examinations of so many articles of each kind, purchased at random from dealers in various parts of New Jersey, and in the city of New York, might justly be regarded as representing a reasonably close approximation to the true facts of the case. In regard to teas, three classes of adulterated samples had been found. The smallest class contained an amount of mineral matter in excess of that which should be present from facing materials alone, or from impurities which could properly be derived from the processes of preparation for the market. The largest class consisted of teas adulterated with exhausted leaves. Finally, in some samples, foreign leaves were present in such numbers as to denote intentional adulteration. But the percentage of adulterated teas was much smaller than was anticipated (10 p.c.), a majority of the teas being of inferior grade, their prices ranging from 30 cts. to 50 cts. per pound. Nearly all the coffees examined, both whole and ground, were pure, the adulterant in the other cases being chicory. The essences of coffee sometimes contained scarcely any coffee; one sample was composed almost entirely of chicory, caramel, and liquorice. The manufacture of mixed sugars, containing both cane-sugar and glucose, is now largely carried on in the United States, the product being sold under the name of "new process" sugar by the manufacturers. This fact had given rise to a popular belief that almost all varieties of sugar were more or less adulterated. Such was not found to be the case, most of the white sugars purchased at random being found pure, and of the brown sugars, which were the more adulterated, certain samples furnished by dealers as in their belief adulterated, were found to contain no more inverted sugar than might properly be present in a sugar of low grade. A similar remark applies to the syrups. Even the lowest-priced syrups were found, with few exceptions, to contain no more glucose than was to be expected in a non-adulterated article. No free sulphuric acid or excess of lime was present in any case. The specimens of flour examined, were uniformly pure, no other meal or alum being found in any instance. In bread, however, sufficient samples showing the employment of alum were obtained, to demonstrate its occasional use by bakers. Cream of tartar was found to be extensively adulterated, the adulterants being sulphate of lime, acid phosphate of lime, and starch. The first-named substance was likewise present in some samples of bicarbonate of soda. Some of the manufacturers of the baking-powders, now so extensively sold, use only bicarbonate of soda, cream of tartar, and starch. Others employ either partly or altogether in place of the cream of tartar, alum or acid phosphate of lime or a mixture of these two salts. Of the condiments and spices, very few were pure, though in no instance was any injurious metallic adulterant detected. Many of the samples of vinegar contained a much lower percentage of acetic acid than should have been present, but in no case were mineral acids present, and in only one instance a metallic substance—lead in traces. Some of the so-called white-wine vinegars had all the characters of ordinary cider vinegar, decolourised by filtration through animal charcoal. None of the *green* pickles examined were free from copper—one pickle containing 15 milligrms.—although the pickles prepared by the use of brine, and those imported with the Crosse and Blackwell label, were found unexceptionable. The employment of tin cans in the preservation of vegetables is reprehensible, both tin and lead being present in the canned tomatoes examined. The skimming and watering of milk was still very extensively practised in New York and New Jersey, although stringent laws had been passed for its repression. Condensed milk varied remarkably in composition, the percentage of water ranging from 25·5 to 59 per cent, and of fat from 3 to 11 per cent.

To a question from Mr. Elliot, Dr. Leeds remarked that he had not made any special tests for gelatine in condensed milk.

Dr. Doremus remarked that one of the first things to decide in this question of adulteration is "What is Adulteration?" and he discussed at some length the question of alum baking powders, claiming that at the present time there is no proof that they are unwholesome.

Dr. E. R. Squibb remarked that he looked upon the question from a different standpoint from most chemists, and would punish as a fraud anything that was sold and not found as represented. He condemned in strong terms the sale of quack medicines, and said that the American people take from five to six times as much medicine *per capita* as any other nation.

Mr. Eimer, of the firm of Eimer and Amend, wholesale druggists, corroborated Dr. Squibb's last statement as to the enormous amounts of patent medicines sold in the United States.

NOTICES OF BOOKS.

Profitable Clay Farming under a Just System of Tenant Right. By John Prout. London: E. Stanford.

The author of this work informs us that he "farms 450 acres of heavy land, all under the plough, and almost entirely devoted to corn," and finds it pay. He does not wish that his land were under grass, nor has he any "intention of replacing any portion of it by forage or root crops for live stock, or by vegetables for the market." Nineteen years' experience has convinced him that in "the present and prospective low state of the markets," it is still possible to secure an adequate return for the tenant's capital, and at the same time afford a satisfactory rent to the owner. This, it need not be said, is a very desirable conclusion. Mr. Prout's system is perpetual corn growing on heavy land by means of deep and cheap steam tillage, and plentiful applications of artificial manures. As preparatory requisites he mentions effectual sub-soil drainage, fields of considerable dimensions, straight and neat fences, sound headland roads, and convenient field water supply. On the question of large or small enclosures and of fences and hedge-row trees, he says: "The drying of the surface of the land and the crops is retarded by the excessive shading of numerous fences, while the produce is exposed to heavy damage by the depredation of infesting birds and vermin." But where the shading of trees and fences is done away with the crops suffer heavily from wind.

On the subject of vermin we fear the author has been guided by prejudice rather than observation. The insects hurtful to our field-crops, such as the Tipula, the wire-worms, the larvæ of the cock-chafer and its allies, the turnip-flea (*Haltica*), &c., do not harbour or breed in trees or bushes, but in the open fields. Nowhere has so much damage been suffered from insects as in the Western States of America, where the system of large fields, separated merely by wire or rail fences, is adopted. Trees certainly harbour birds, but the insect-eating species will suffer more from their removal than the chief grain-devourer, the sparrow. The expenditure for manure is at the annual rate of £2 10s. per acre. Dr. Voelcker, in an exhaustive report, based on analyses of the soil made at different times, states: "I can perceive no indications of incipient exhaustion, but, on the contrary, clear evidence of the great improvement effected in once unproductive land. I can see no reason why, with this system of manuring, and an occasional dead summer fallow, in order to give a

thorough cleaning to the land, Mr. Prout should not be able to grow wheat or barley profitably for an indefinite number of years without injury to his land." Lime has been experimentally applied to some of the fields, but, as Dr. Voelcker attests, without beneficial results. The store of potash in the soil may ultimately become exhausted if no provision is made for its supply. Small quantities of kænite have accordingly been used. The principal manures consumed have been of the phosphatic class, bone meal, mineral superphosphate, and Peruvian guano, both raw and dissolved. According to Dr. Voelcker's analysis, 6 inches of soil from the "Broad Field"—a portion of the farm in question—contain as much phosphoric acid as 118 good crops of wheat, as much potash as 212 such crops, as much sulphuric acid as 215 crops, as much magnesia as 1120 crops, and as much lime as 2256 crops. The restoration of silica Dr. Voelcker thinks needless, there being not a single instance on record showing that silica, even in the soluble form, has ever been applied with advantage to grain crops.

Both the author and Dr. Voelcker question whether bone manures have not been applied with somewhat too great liberality. The results of the nineteen years' farming are considered to prove the necessity of supplying grain-crops with ammoniacal manures, or such as otherwise contain nitrogen in a readily available condition. The profits of the undertaking have been on an average £1142 yearly, or about £3 per acre.

The question now arises why should not other farmers do as Mr. Prout has done and is still doing? The reply involves political considerations into which the Chemical News cannot enter. We quote merely the author's words: "I could not have stirred a step in my career of success at Sawbridgeworth if I had been hampered by estate rules, written consent to works proposed, restrictions as to fences or water-courses, lopping of timber, understanding about game, &c."

We commend this little book to the careful examination of all our readers.

Alcohol Tables, giving for all Specific Gravities from 1·000 *to* 0·7938 *the Percentages of Absolute Alcohol by Weight and Volume, and of Proof Spirit.* By Otto Hehner. Reprinted from the *Analyst*. London: J. and A. Churchill.

These tables, for which no originality is claimed, and the nature of which will be apparent from the title, are founded upon the tables of Fownes, the general accuracy of which, according to the author, all later investigators have confirmed—a statement which is by no means universally accepted. The results of Fownes differ at certain points from the earlier determinations of Gilpin to ½ per cent of proof spirit. We cannot help considering it as unfortunate that the notion of "proof spirit" should still be retained. It would be assuredly far simpler to speak of spirit as containing such or such a percentage of absolute alcohol.

Inorganic Chemistry: Adapted for Students in Elementary Classes of the Science and Art Department. By Dr. W. B. Kemshead, F.G.S., &c. Enlarged edition, revised and extended. London and Glasgow: W. Collins, Sons, and Co., Limited.

This book forms a member of the Science Series issued by Messrs. Collins. It is in its objects and tendencies avowedly examinational. The author is examiner in chemistry to the College of Preceptors, and the work, as we are told in the preface, was "originally issued for the first stage or elementary examination of the Science Department," whilst the present edition owes its origin to "a very generally expressed wish that the work might be extended in the same spirit, to include all the subjects required for the matriculation examination of the London University."

It is put forward as an important feature that the treatise before us is the only text-book in existence which combines the notation used by Prof. Williamson and his school with the graphic notation of which Dr. Frankland may be regarded as the chief teacher.

One of the author's reasons for bringing out a new edition of his work is the fact of many important discoveries having been made "within the last three years." Surely among the most weighty of recent discoveries—though made earlier than "within the last three years"—is the periodic law of Prof. Mendelejeff. It apparently "throws open to us a vista which may possibly revolutionise the whole science." Yet we do not find the slightest allusion in the work before us to this signal step in advance.

Under fuming sulphuric acid we find the erroneous assertion that ordinary sulphuric acid will not dissolve indigo. In practice by far the greater part of the extract of indigo used is made with ordinary oil of vitriol, and not with the fuming or so-called Nordhausen acid. The metallic elements are not here described, an acquaintance with their properties being probably not called for in the examinations for which the book is arranged.

The great bulk of the matter here laid before the student is, as might be expected from a teacher of Dr. Kemshead's standing and merit, strictly accurate in fact, unexceptionable in arrangement.

Lecture Notes for Chemical Students. Vol. II. *Organic Chemistry.* By E. Frankland, Ph.D., F.R.S., &c. Third edition. Revised by F. R. Japp, Ph.D. London: Van Voorst.

One of the most difficult tasks which a reviewer in these days can be called upon to undertake is to pronounce an opinion upon an elementary work on chemistry. The number of such manuals, treatises, &c., issuing from the English press is so great, and their subject matter necessarily so much alike, that it becomes scarcely possible to say anything which shall be acceptable to all the parties interested. The question is further complicated when, as in the present case, the author is a chemist of indisputable eminence, and when the work has already passed through several editions, and has not merely run the gauntlet of criticism, but stood the severer test of actual use. The search for errors, in fact, against which the reader should be warned, is here hopeless.

The chief merit of the book—and it is one of very high importance—is that it places before the eye of the student the apparently infinite and desultory array of organic compounds as reduced under definite groups, converting them, so to speak, from a mob into an army. By the classification adopted, the "description of the individual member" is, as remarked in the preface, "made subsidiary to that of the family to which they are attached." Hence the study of organic chemistry makes a less demand upon the memory—the faculty, too, exclusively and one-sidedly cultivated in the English system of education—and a greater call upon the understanding. Any agency tending in this direction we welcome with pleasure. From a truly scientific point of view nothing can be more unprofitable than the mere contemplation of a number of facts among which no connection can be traced. Whether everything laid down in these Lecture Notes, *e.g.*, on the "constitution" of certain compounds, is capable of demonstration is another question.

"Graphic formulæ" constitute, of course, an essential feature. We fully admit that there are minds who by means of this artifice are enabled to form a clearer idea of the composition of bodies; but our observation convinces us that there are other minds utterly incapable of profiting by or of remembering such formulæ, and whose only thought on meeting with them will be the demand for proof that the atoms are really arranged as represented. If told that this is more than the advocates of graphic formulæ contend for, they will ask why, then, is such

weight laid upon this mode of representation? Is there not too free play given to hypothesis? (See p. 53).

The work, after an introductory chapter, treats successively of organic radicles classified as positive and negative, of their hydrides, of the alcohols, the ethers, haloid ethers, aldehyds, acids, anhydrides, ketons, ethereal salts, organic compounds containing triad and pentad nitrogen, the organo-boron and organo-silicon bodies, and organo-metallic compounds. The indigo group, according to the latest researches of Prof. Baeyer, is given as an appendix.

The "Lecture Notes" may be regarded as a successful attempt to give a clear oversight of the field of organic chemistry in the briefest compass.

Text-Book of Practical Organic Chemistry for Elementary Students. By H. CHAPMAN JONES. London: Hughes.

THIS work is not put forward as a systematic treatise on organic chemistry. It does not give an account of all the various groups of compounds commonly known as organic, but is intended as a laboratory companion for students who are studying practically, and whose time for work is very limited. The experiments selected are such as can be performed without expensive appliances, whilst at the same time the author has sought to give them a representative character. A very considerable portion of the book—which, by the way, would have been all the better for a table of contents—is devoted to the recognition of the organic acids. For the purposes which the author has in view we are inclined to form a favourable opinion of this little treatise.

CORRESPONDENCE.

THE ACTION OF NITRIC ACID ON METALS.

To the Editor of the Chemical News.

SIR,—I feel as if I were dreaming on receiving the question of my friend D. Tommasi! I cannot imagine how a mind such as his can see "an obscure point" of "la Théorie Générale," in the fact, that 14Sn in *chemical presence* of nitric acid of a given strength, will leave 6Sn, not *useless*, but *inactive*, which is very different.

How would my friend D. Tommasi reply to the question?—

When you add 2 equivalents of KO and $(2+x)$ equivalents of SO_3HO, why can you only obtain $(SO_3)_2,KO,HO$; and why are the x equivalents left unemployed?

Why even in classical language are they absolutely useless?

What real difference can one find between this question and that which I am asked?

Is there anything more completely explained in my theory than this *non-employment* of 6Sn at a *given temperature*?

But may I be allowed to give a complete explanation. If we were to submit the mixture to 100° of cold (perhaps a lowwer temperature would be necessary), we should see all the 14Sn remain unemployed. Should we be astonished?

If, on the other hand, we submit the mixture at the ordinary temparature (or higher) to a very great pressure, we should see all the 14Sn take part in the reaction, and we should have:—

$$14Sn+NO_5(HO)_{10}=6Sn_2O+2SnO+NH_3+7HO$$

(I predict Sn_2O for abbreviation). Should we be any more astonished?

If my friend Tommasi will think over this theory, which merits more good will and attention than it has received, he will regret having asked so trivial a question.

Let him consider that the basis of this theory is *incontestable*—that of all reflections made concerning the explanation of chemical reactions, it is the only one which survives in this case; and he will be careful not to attack any of its consequences.

Perhaps I am wrong. Let my learned friend take the trouble to show it to me. I have often begged my *confrères* to do this service to science, but nobody has done it. All prefer to continue the use of an hypothesis which I have shown to be wrong, as clearly as one can establish a scientific truth. The shame of such a prolonged determination to remain in error, becomes altogether unpardonable in the eyes of those who seek the truth.

May D. Tommasi understand it!—I am, &c.

E. MAUMENÉ.

Lyons, July 11, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 24, June 13, 1881.

Simple Law Relating to Natural or Magnetic Circular Double Refraction.—A. Cornu.—The author sums up the results of his experiments as follows:—1. In quartz the mean of the speeds of propagation along the optical axis of the circular waves of inverse directions is sensibly equal to the speed of the ordinary wave perpendicular to that axis. 2. In Faraday's heavy flint glass the mean of the speeds of propagation of circular waves of inverse directions separated by the magnetic action is sensibly equal to the common speed of these waves when the magnetic action is null. He proposes the following more general statement:—The splitting up of a wave polarised rectilinearly into two waves polarised circularly in opposite directions is effected in such a manner that the mean of the speeds of propagation of the split up waves is equal to the speed of propagation of the single wave, which exists in conditions where the causes of splitting up do not act.

Dialdanic Alcohol.—A. Wurtz.—The alcohol in question has the composition $C_8H_{16}O_3$, and is at once a primary and a secondary alcohol and an ether. It does not fix directly either bromine or hydrogen. It forms a white crystalline mass, deliquescent and soluble in all proportions in water and alcohol, and very soluble in ether.

Reproduction of Orthose in the Wet Way.—C. Friedel and E. Sarasin.—The authors have obtained this mineral by heating together gelatinous silica, alumina, and a solution of potash, in a strong steel tube, lined internally with a tube of copper or platinum, and heated to dull redness.

Summary Account of Experiments made at Pouilly-le-Fort, near Melun, on Vaccination for Splenic Fever.—M. Pasteur.—The experiments have proved decidedly successful. The new "verus-vaccine" for splenic fever can be cultivated at pleasure, transported without spoiling, and preserves the animals into which it is produced from a mortal disease. The method by which the virus is produced seems capable of generalisation.

Influence of Temperature upon Radiophonic Receivers of Selenium.—E. Mercadier.—The selenium radiophonic receivers constructed according to the author's description tend, in time, more or less rapidly to a state of stability as regards the effects of temperature. At ordinary temperatures, and even up to 100°, the resistance of these receivers varies inversely as the temperature. Between 5° or 6° and 35° these variations may be considered as approximately proportional to each other.

Certain Means and Formulæ for Measuring Electric Elements and Coefficients of Utilisation with the Dispositive with two Galvanometers.—G. Cabanellas.—A mathematical paper, not susceptible of useful abstraction.

Strontium, Calcium, and Zinc Cyanides.—M. Joannis.—A study of the formation- and solution-heats of these compounds. The author remarks that zinc cyanide, though insoluble in water and hydrocyanic acid, is slightly soluble in solutions of zinc sulphate and acetate.

Industrial Preparation of Crystalline Formic Acid.—M. Lorin.—The author sets out with mono-formine, which is obtained by heating glycerin with an equivalent proportion of dried oxalic acid, or from the product of glycerin submitted to the action of a quantity of 4 or 5 equivalents of dry oxalic acid, added successively, when it is partly decomposed. Too much time must not be left between the additions. The author has operated upon 560 grms. glycerin and has added the acid in quantities of 600 grms. each.

Researches on the Tertiary Monamines.—1. Action of Tri-ethylamine upon the Monobromised Propylenes.—E. Reboul.—Not adapted for abstraction.

No 25, June 20, 1881.

Preparation of Aldol.—M. Wurtz.—2 kilos. of aldehyd and 2 kilos. of water were introduced into 2 kilos. of hydrochloric acid, and the mixture was left to itself for 3 days at 15°. The liquid was then diluted, neutralised with sodium carbonate, and repeatedly exhausted with ether. The product was 497 grms. aldol, which distilled over between 85° to 105°. The aldol thus obtained, though perfectly fluid at first, became a thick colourless syrup, entirely soluble in water.

New Occurrence of Native Sulphur in the Soil of Paris.—M. Daubrée.—The deposit of sulphur seems due not to the escape of coal-gas, but to the reaction of organic matter upon gypsum. There is a bed of the bones of animals, mixed with the horns of oxen extending from the depth of 2·50 to 4·50 metres, and which has been traced for a length of 40 metres!

Thermic Laws of the Exciting Spark of Condensers.—E. Villari.—The author calls the "exciting spark" of the discharge of a condenser that which is produced against the exciter, whilst the "conjunctive spark" is that formed in an interruption. He finds that the heat evolved by the exciting spark alone is almost proportional to the square of the charges, and increases a little less rapidly than the charge when the potential is constant.

Formation-Heat of Calcium Oxychloride.—M. André.—The union of water with anhydrous oxychloride evolves more heat than the hydration of calcium chloride, which explains the formation of the oxychloride in the presence of water.

Action of Lead Protoxide upon the Alkaline Iodides.—A. Ditte.—This reaction may yield in one and the same liquid:—1. Decomposition of lead oxide by potassium iodide with formation of potash and oxyiodide, partly dissociated. 2. Decomposition of lead iodide by potash with the production of lead oxide and alkaline iodide. At a given constant temperature there are an infinite number of proportions of potassium iodide and potash capable of remaining in equilibrium with lead oxide and iodide.

Basic Calcium Carbonates.—F. M. Raoult.—The author obtains a bibasic carbonate by passing carbonic acid over dry calcium oxide at dull redness. The compound differs from a mixture of lime and of the neutral carbonate by certain properties. If exposed to the vapour of water it does not become hydrated, and if moistened with water it sets like a hydraulic cement without heating.

Influence of the Concentration of Hydrochloric Acid upon the Solution of Silver Chloride.—F. Ruyssen and E. Varenne.—The solubility of the salt decreases very rapidly with the dilution of the acid. An acid at 40 per cent dissolves 1-236th part of silver chloride; one at 5 per cent only 1-5626th part. The concentration of the salt also affects the solubility.

Action of Arsenic and Phosphoric Acids upon Sodium Tungstates.—J. Lefort.—With neutral sodium tungstate arsenic acid produces a double salt composed of sodium arseniate and tritungstate. On heating meta-tungstic acid is produced, which remains in the mother-liquor. With sodium bitungstate in the proportions of 4 parts of the salt to 1 of arsenic acid, there are formed sodium tritungstate and meta-tungstic acid. If the proportion of arsenic acid is doubled and the mixture heated to a boil for some time, renewing the water as it evaporates, the liquid acquires a yellowish tint, and there is formed an isomeric variety of meta-tungstic acid, which the authors name meta-luteo-tungstic acid.

Researches on Tertiary Monamines: Action of Heat on Allyl-triethyl-ammonium Bromide.—E. Reboul.—Allyl-triethyl-ammonium bromide, if heated in presence of a little water, yields triethylamine, diethyl-amine, and a primary ammonia (probably allylamine), also ethyl bromide, allyl bromide, and ethylen.

Microzymas of Chalk.—A. Béchamp.—The author refers to his former memoir (*Comptes Rendus*, lxiii., p. 453) to show that the necessary precautions to avoid error were not omitted, and that check-experiments were made with pure chalk, which gave negative results.

Justus Liebig's Annalen der Chemie,
Band 206, Heft 1 and 2.

Researches on the Non-Saturated Acids (Part 4).—Rudolph Fittig.—These consist of a memoir on the citraconic and mesaconic acids, by Paul Krusemark; a paper by H. Kast, on the atro-lactic, phenyl-lactic, and atro-glyceric acids; and a memoir by R. Fittig, on the isotropic acid.

Communications from the University Laboratory at Graz.—These comprise a memoir on the boiling-point of hypochloric acid, which the author, G. Schacherl, finds to be 9·9°. He observes, further, that the acid distils without explosion if it does not come in contact with any organic matter, such as caoutchouc or cork.

E. Fürst gives an account of the behaviour of hypochloric acid with potassium permanganate. Like hyponitric acid, the hypochloric acid is capable of acting both as an oxidising and a reducing agent. It reduces potassium permanganate very rapidly to manganese binoxide, potassium chlorate and hydrochloric acid being produced.

The same author has examined the behaviour of hypochloric acid with æthylen. The first result is the formation of mono-chlor-acetyl-chloride, water, and oxygen, the two former compounds being afterwards re-arranged as hydrochloric acid and mono-chlor-acetic acid.

The Condensation-Products of Aromatic Bases.—Otto Fischer.—The following general conclusions are drawn by the author from the numerous experiments described in this long and important paper:—In the products which arise from alcohols (benzyl-alcohol, benzhydrol) or aromatic acids (benzoic acid) with bases, the catenation takes such a form that water is separated and a molecule of the acid or the alcohol unites with each molecule of the base. In the compounds formed by aldehyds and bases water is formed and two molecules of the base combine with one molecule of the aldehyd. Anhydrides (benzoic, phthalic) behave like the aldehyds. In the fatty chlorides and the aromatised fatty chlorides the catenation with the bases is effected by the exit of hydrochloric acid. For every atom of chlorine there is introduced a phenyl residue, provided that the compound formed contains at most three phenyl residues combined with one atom of carbon. A single atom of carbon cannot retain more than three benzol residues. In the acid chlorides the process of condensation may be twofold;

either the catenation is attended with the exit of hydrochloric acid, keton-like bodies being formed, or it is accompanied with the elimination of water, as in the aldehyds.

Constitution of Arbutine.—H. Schiff.—The author considers that the substance analysed by Hlasiwetz and Habermann was a mixture of arbutine and methyl-arbutine.

Sulphamic and Oxy-Acids Derived from Mesitylen.—O. Jacobsen.—The author has examined in detail ortho-sulphamin-mesitylenic acid, the corresponding para-compound, sulphamin-uvitic acid, sulpho-uvitic acid, oxy-uvitic acid, sulphamin-trimesinic and oxy-trimesinic acids and their salts.

Researches on Levulinic Acid, or β-Aceto-propionic Acid.—These comprise a paper on the preparation and properties of levulinic acid, by A. v. Grote, Dr. E. Kehrer, and B. Tollens; memoirs on the production of levulinic acid from dextrose and milk sugar; an essay on its transformation into normal valerianic acid, and a paper on the hydrocarbons obtained as by-products during the reaction of hydrogen iodide upon levulinic acid.

Communications from the Laboratory of the University of Würzburg.—These consist of a memoir by Dr. R. Friedrich on dichlor-aldehyd-hydrate, and a memoir on the dry distillation of potassium dichloracetate, by the same author.

Band 206, Heft 3.

Researches on Lævulinic Acid or β-aceto-propionic Acid (Part 4).—This consists of an investigation on the oxidation of lævulinic acid, by B. Tollens. The author shows that the products of the action of dilute sulphuric acid are the succinic, acetic, carbonic, oxalic, hydrocyanic, and probably the formic acid, along with ammonia. Butyric acid is certainly not formed and the malonic acid could not be recognised.

The Naturally-occurring Mydriatic Alkaloids.—A. Ladenburg.—An account of the occurrence of these alkaloids in the Solanaceæ, and a description of a new base, hyoscine. Atropine occurs in *Atropa belladonna* and *Datura stramonium*, and resolves itself into tropic acid and tropine. Hyoscyamine is found in *Atropa belladonna*, *Datura stramonium*, *Hyoscyames niger*, and *Duboisia myoporoides*, and yields the same decomposition-products. Hyoscine occurs in *Hyoscyamus niger*, and yields tropic acid and pseudotropine. The three mydriatic alkaloids are isomers.

Communications from the University Laboratory of Würzburg.—These consist of a memoir by J. Wislicenus on the progress of the splitting up of polyvalent acetic esters by alkalies; a paper on two homologues of aceto-propionic acid, by C. Bischoff; an account of the synthesis of glyceric acid by means of mono-chlor-lactic acid, by E. Frank; a memoir on cetylacetester, cetyl, and dicetyl-malonic acid and their decomposition-products, cetyl- and dicetyl-acetic acids, by M. Guthzeit; and on the coal-tar oils whose boiling-points lie between that of naphthalin and that of acenaphthen, by F. Reingruber. The author commences with an account of methyl-naphthalin and the so-called diphenyl.

Moniteur Scientifique, Quesneville.
February, 1881.

The Odours of Paris.—Aimé Girard.—In this report we have a history of the processes by which the solid fœcal matters of Paris, removed on the pail system, have been treated in various suburban localities with a view to their disinfection and conversion into manure. The report recommends that all fœcal deposits in the open air, including the municipal cesspool of Bondy, ought to be totally suppressed, and the stock of fœcal matter accumulated there ought to be converted into dry manure with the least delay. All open-air deposits and manipulations of fœcal matters, liquid or solid, should be completely interdicted. All work-rooms, or tanks in which sewage-matters or their odorous derivatives are exposed to the contact of the air, and all apparatus in which such matters are treated should be inclosed with walls having only two openings, one for the entrance of the external air, and the other for the exit of the contaminated air, which should be connected with draught arrangements so constructed that the gases evolved cannot under any circumstances become diffused in the atmosphere. The treatment of the sewage-matters should include either the rapid desiccation of the whole refuse by means of artificial heat, or the drying up of the solids only, and the conversion of the liquids into ammoniacal salts. Before desiccation these substances should be mixed with a quantity of disinfectants sufficient to fix the hydrogen sulphide and the ammoniacal salts volatile at 100° F.

Coto-Barks and their Characteristic Elements.—J. Jobst and O. Hesse.—From the *Annalen der Chemie*.

Detection of the Accessory Alkaloids in Commercial Quinine Sulphate.—Dr. G. Kerner.—The author bases his method upon the following principles:—Among the neutral sulphates of the cinchona alkaloids quinine sulphate is the least soluble in cold water, and quinine hydrate is among all these bases the one most easily absorbed by ammonia. The solution, saturated in the cold, of chemically pure quinine sulphate contains always a constant quantity of alkaloid, which is precipitated from the solution by a constant quantity of ammonia, and redissolved by an unvarying excess of this liquid. The reaction of this re-solution may be observed with great precision.

Water and Air.—Dr. J. Tyndall.—From the *Journal of Science* for January, 1880.

Constitution of Ultramarine.—H. Endemann.—From the Chemical News.

Review of Chemical Researches Published in Germany.—Extracts from the *Berichte der Deutschen Chem. Gesell.*

Chemiker Zeitung.
IV., No. 20.

Retrospect of the Chemical Arts for the First Quarter of 1880.—Among the principal points brought forward is the failure of recent attempts to dispense with the lead chambers in the manufacture of sulphuric acid. Among the many new colours produced the only one for which success is expected is the red colour obtained by Grässler on treating sulphamido-azo-benzoic acid with β-naphthol. Anisol is now prepared on the large scale by means of methyl chloride, but the nitration of this body still presents serious difficulties.

Apparatus for the Volumetric Determination o Nitrogen.—Prof. H. Schwarz.—This paper cannot be intelligibly reproduced without the accompanying wood-cut.

Recovery of Old Vulcanised Caoutchouc.—The pieces are heated in contact with steam, when the sulphur is volatilised and the caoutchouc melts and is collected as a liquid, used in preparing water-proof covers, &c.

Meeting of the Industrial Society of Mulhouse.—A paper was read by Schmid on the direct preparation of cadmium sulphide upon tissues. It is proposed to print on a mixture of arsenious acid, sulphur, sodium acetate, and cadmium nitrate. A very fine yellow is obtained by steaming for one to two hours, and a bright orange is produced by increasing the proportion of sodium acetate.

Preservation of Meat.—In Vienna meat is prepared on the large scale for the Paris and London markets by exposure to cold and treatment with powdered borax.

Sodium Salicylate in Yellow Fever.—According to Dr. Freire hypodermic injections of this salt have been successfully used at Rio Janeiro in the earlier stages of yellow fever.

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THE CHEMICAL NEWS.

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ON SOME HITHERTO UNDESCRIBED SELENIUM COMPOUNDS.*

By CHARLES A. CAMERON, M.D., and EDMUND W. DAVY, M.D.,
The Professors of Chemistry, and of Forensic Medicine, Royal College of Surgeons, Ireland.

THE authors have succeeded in forming the different selenium compounds noticed in this abstract, which have not (as far as they are aware) been hitherto described.

Neutral Mercuric Selenate, $HgSeO_4$, is prepared by heating freshly precipitated mercuric oxide with selenic acid until a white compound is formed, filtering and evaporating to dryness, and heating to expel free acid. The salt may also be made by adding an excess of selenic acid to mercuric acetate, evaporating and heating the mixture to remove free selenic and acetic acids. It is a white salt, which dissolves in selenic acid, and from which solution it may be obtained in small crystals by its spontaneous evaporation. It is soluble also in sulphuric, nitric, and hydrochloric acids, but it is decomposed by water into a basic salt and free selenic acid, which latter retains a little mercuric selenate in solution.

Basic Mercuric Selenate, $HgSeO_4(HgO)_2$, may be prepared, as already stated, by the action of water upon the neutral salt, or more readily, by precipitating mercuric acetate by a soluble selenate or by selenic acid. It is a fine red salt, which is soluble in selenic, sulphuric, nitric, and hydrochloric acids; but it is very sparingly soluble in water, for even when freshly precipitated, it requires about 10,330 times its weight of that liquid for solution.

No acid mercuric selenate appears to exist, for the neutral salt treated with water produced, as already stated, the basic salt and free selenic acid, the reaction being as follows:—

$$3HgSeO_4 + 2H_2O = HgSeO_4(HgO)_2 + 2H_2SeO_4;$$

and on separating the acid liquid, and allowing it to evaporate *in vacuo* over sulphuric acid, crystals were obtained which proved to be the neutral selenate. The evaporation in the same way of a solution of the neutral mercuric selenate in selenic acid yielded only crystals of the neutral salt.

Mercurous Selenate, Hg_2SeO_4, is prepared by adding selenic acid, or an alkaline selenate to mercurous nitrate. It is a greyish white amorphous substance, which is very slightly soluble in water. It is insoluble in hydrochloric acid, and when boiled with nitric acid is converted into mercuric selenate, with the evolution of nitrogen dioxide. This salt is remarkably susceptible to the influence of light, a few moments' exposure being sufficient to cause darkening, even in diffused daylight.

Di-mercurammonium Selenate, $(NHg_2)_2SeO_4,2H_2O$.—Mercuric selenate forms with ammonia a compound analogous to the so-called ammoniacal turpethum, the dimercurammonium sulphate, $(NHg_2)_2.SO_4.2H_2O$. Thus, when the neutral, or freshly prepared and still moist, basic selenate is treated with a strong solution of ammonia it dissolves, but on the addition of water an abundant white precipitate appears, which is the compound in question. This salt dissolves readily in hydrochloric acid and in strong ammonia. It is blackened by exposure to the light, and when strongly heated it is decomposed, with the evolution of nitrogen, ammonia, and the vapour of water, basic mercuric selenate being left.

Action of Selenic Acid upon Mercury.—The authors have studied the action of selenic, as compared with sulphuric, acid on mercury. When the latter acid is heated with that metal a sulphate, with the evolution of sulphur dioxide, results, as is well known. When, however, selenic acid is heated with an excess of mercury, a selenite and not a selenate is formed. In this reaction a molecule of water is replaced in the acid by an atom of mercury, thus:—$Hg + H_2SeO_4 = HgSeO_3 + H_2O$. If an excess of acid, however, be used, the selenite first formed is decomposed and a selenate is produced. A mixture of mercurous and mercuric selenites is the usual product of the action of selenic acid upon an excess of mercury.

The authors have repeated the processes by which it is alleged an acid mercuric selenite is procurable, but they found that the compound described as biselenite of mercury is merely neutral selenite with a little selenious acid, and every attempt made to form an acid mercuric selenite failed.

Seleno-cyanides. — The authors succeeded in forming several hitherto undescribed simple and double seleno-cyanides; amongst the former the following were described:—

Mercuric Seleno-cyanide, $Hg(CySe)_2$, hitherto only obtained in the form of a double salt, was readily procured by adding potassium seleno-cyanide to mercuric acetate. It cannot be precipitated from mercuric chloride,—hence the previous failures to form it, as that salt had been used. From the acetate it is thrown down as a white felt-like mass, which must be dried over sulphuric acid, as the heat of the water-bath decomposes it. This salt is very sparingly soluble in cold water, but dissolves to a much greater extent in it when hot. It dissolves freely in alkaline cyanides, seleno-cyanides, and sulpho-cyanides, with all of which it forms double salts. In a hot solution of mercuric chloride it is likewise soluble, and the solution on cooling yields beautiful feathery crystals of the mercuric seleno-cyanide and chloride, the double salt already described by Mr. Crookes. Mercuric seleno-cyanide darkens on exposure to light, and when strongly heated it decomposes in a remarkable way, similar to that of its sulphur anologue, the combustion of which produces the intumescence known as Pharaoh's Serpents.

Mercurous Seleno-cyanide, $Hg_2(CySe)_2$, is prepared by adding a solution of an alkaline seleno-cyanide to one of mercurous nitrate. It is an olive-green compound, which must be dried over sulphuric acid, as it is decomposed by the heat of a water-bath. During combustion it intumesces, but only slightly. Nitric acid converts it into mercurous selenate, and hydrochloric into mercurous chloride, with separation of selenium.

Ammonium Seleno-cyanide, NH_4CySe.—This salt, though previously described by Mr. Crookes, is here noticed, as the authors prepared it by a new process, which consisted in digesting in alcohol a mixture of potassium seleno-cyanide and ammonium sulphate, which was found to be a very ready means of preparing this compound. Ammonium seleno-cyanide very closely resembles its sulphur analogue, but decomposes very readily. Its solution in water is attended by the production of great cold. Attempts to form selen-urea by heating ammonium seleno-cyanide gave unsatisfactory results, though it was probable that some selen-urea was thus formed.

Amongst the double salts which the authors succeeded in forming, the following are perhaps the most interesting:—

Potassium Seleno-cyanide and Mercuric Cyanide, $KCySe + HgCy_2$.—This salt is formed when to an aqueous —or, better still, alcoholic—solution of potassium seleno-cyanide mercuric cyanide in strong aqueous solution is added, when an immediate crystalline precipitate will be produced. This, on examination under the microscope, was found to consist of long fine prismatic crystals, which when dry have a white silky appearance, and seem to undergo no change even by prolonged exposure to the air. The salt dissolves but slowly and sparingly in cold water, and is still less soluble in cold alcohol, though in both

* Abstract of a Report read before the Royal Irish Academy, June 27, 1881.

liquids its solubility is much increased by heat. It is only to a very trifling extent dissolvable by ether, even when boiled in it. When heated with diluted hydrochloric acid its constituent selenium slowly separates, hydrocyanic acid being at the same time evolved.

Potassium Seleno-cyanide and Mercuric Sulphocyanide, $KCySe+Hg(CyS)_2$.—This salt is formed when an aqueous solution of potassium seleno-cyanide is heated along with mercuric sulphocyanide. The solution being filtered to separate the black matter that is formed, which appears to consist chiefly of mercuric sulphide, the filtrate on cooling yields long prismatic colourless crystals of this double salt, which when dry possesses a somewhat glistening appearance. This compound on being treated with a ferric salt develops the blood-red reaction of the sulphocyanides, and when heated with hydrochloric acid, selenium separates, whilst at the same time hydrocyanic acid is evolved; and, lastly, when heated in a tube, it yields, besides other products, a sublimate of metallic mercury. Like the double salt just described, it is sparingly soluble in both cold water and alcohol, but dissolves in either more readily on the application of heat, and these solutions on cooling or by evaporation yield long flat prismatic crystals, which possess considerable permanence; for some of the salt which had been exposed to the air for several months appeared to have undergone no change. This salt is soluble to some extent in ether, at least when boiled in it.

Potassium Seleno-cyanide and Mercuric Seleno-cyanide, $KCySe+Hg(CySe)_2$.—Mercuric seleno-cyanide dissolves readily in a solution of potassium seleno-cyanide, especially on the application of heat, and the solution on cooling or evaporation furnishes long prismatic six-sided crystals of the double salt, which remained unchanged on exposure to the air. This salt is readily soluble in water, even at the ordinary temperature, but dissolves slowly and sparingly in cold alcohol; in hot, however, it is soluble to a considerable extent. This compound was not quantitatively analysed, but there can be but little doubt that its composition is similar to the preceding salts, and that it consists of one molecule of the alkaline seleno-cyanide with one of the mercuric salt.

Potassium Seleno-cyanide and Mercuric Iodide,—

$KCySe+HgI_2$.

Mercuric iodide dissolves readily and completely in an aqueous or alcoholic solution of potassium seleno-cyanide, forming a colourless or faintly yellowish solution, which, if it is not too dilute, after a few moments yields colourless crystals of the above double salt. These when dry possess a pure white and somewhat pearly appearance, and when crystallised from an aqueous solution assume generally the form of thin plates, which are for the most part very irregular in their outline. The salt is sparingly soluble in water and in alcohol at the ordinary temperature, but dissolves readily in either on the application of heat. When this double salt is treated with diluted hydrochloric acid it immediately becomes yellow, then orange or scarlet, from the separation of its mercuric iodide, which subsequently dissolving in the excess of acid, the solution becomes perfectly colourless, whilst hydrocyanic acid is evolved, but this solution on being heated gradually becomes reddish brown from the separation of the constituent selenium of this salt.

An attempt was made to form a corresponding double salt with the green or mercurous iodide, but on treating it with a solution of potassium seleno-cyanide, metallic mercury separated, with the formation of the double salt just described.

Potassium Seleno-cyanide and Mercuric Chloride, $KCySe+HgCl_2$.—When to an aqueous or alcoholic solution of potassium seleno-cyanide, mercuric chloride in aqueous solution is added drop by drop, the white precipitate or effect at first produced instantly re-dissolves up to a certain point, when a colourless crystalline salt is formed, which remains. If, however, the addition of the mercuric chloride be continued, a light yellow compound will be formed after a certain amount of the chloride has been added. The white crystalline salt at first formed is a compound of potassium seleno-cyanide and mercuric chloride, a salt which is analogous to the double salts already described. This statement appears at first to be opposed to Mr. Crookes's results, who has stated that he obtained by the action of potassium seleno-cyanide on mercuric chloride a yellow salt consisting of mercuric seleno-cyanide and mercuric chloride. But in his experiments an excess of the mercuric chloride was employed in forming his double salt; whereas, in this case it was carefully avoided, and under these two opposite conditions two different salts are formed. This salt when quite dry has a very faint yellowish tint or shade, and like the double salts already described is sparingly soluble in cold water and alcohol, but is much more soluble in either solvent on the application of heat.

Potassium Seleno-cyanide and Mercuric Bromide, $KCySe+HgBr_2$.—Mercuric bromide acts in a perfectly similar manner to that of the mercuric chloride on potassium seleno-cyanide, and forms a corresponding double salt under the same conditions as those in the case of the chloride. The bromide salt crystallises in long flat prismatic crystals, which have a somewhat glistening appearance, and, like the other double salts, is sparingly soluble in cold water and in alcohol, though it dissolves more freely in both when heated.

It was ascertained that the different preceding double salts could be readily obtained by boiling together in water due proportions of potassium cyanide and precipitated selenium, and then adding the mercuric salt, and after continuing the heating for a short time, filtering the mixture whilst still hot, when the filtrate on cooling will yield crystals of the double salt. By this very simple means we may thus avoid the trouble of preparing, first, potassium seleno-cyanide by the process usually employed for its preparation.

In conclusion, the authors state that the formulæ which they have given for the different new salts they have described have been derived from the results of their chemical analyses of those compounds.

CONTRIBUTIONS TO THE CHEMISTRY OF BAST FIBRES.

Part III.

By E. T. BEVAN and C. F. CROSS.

A short time since we published a note upon the progress of our researches upon this subject, in which we announced our conclusion of the identity of the aromatic constituents of these fibres with the tannin group. Subsequently to this, we have examined the products of fusion of these bodies with potassic hydrate according to the usual method, and have obtained a considerable yield of protocatechuic acid together with phloro-glucin in small quantity, sufficient for qualitative identification. This fills up the only remaining gap in the evidence upon which our conclusion is based. It is likewise noticeable, that by the action of sulphuric acid upon the Esparto "resin," it is converted into substances resembling those obtained from digallic acid by the same treatment. Studying, in the next place, the action of the concentrated acid upon the jute fibre as a whole, we have obtained very interesting results, of which the following is a brief account.

On titrating the fibre in contact with the acid, it is dissolved to a viscous purplish solution; on heating this for a short time to 80° to 90°, and then pouring into water, the whole of the fibre substance is precipitated as a black spongey mass. This is converted by the action of Cl, in presence of water, into an orange coloured substance (or mixture), soluble in alcohol and in alkalies without residue, and closely resembling the aromatic chloro-derivatives

previously described by us. A large proportion of the black precipitated mass being evidently derived from the *cellulose* of the fibre, we proceeded to investigate the probability of *its* conversion into aromatic products, hereby suggested. Bleached cotton was titrated with the strong acid till dissolved, and heated to 80° to 90°. At this temperature the liquid effervesced copiously and gave off a strong smell of acetic acid; after a few minutes it thickened and swelled up to a voluminous black mass, which was purified by repeated treatment with water. Analysis showed it to contain 59 per cent C and 3·4 per cent H. On treatment with a mixture of potassium chlorate and hydrochlorate acid (dilute) in the cold, it was converted into a bright orange-coloured substance, entirely soluble in alcohol; soluble in alkalies to brown solutions, and in sodium sulphite solution with development of a red colour. Not only were its properties found to be closely similar to those of the chloro-derivatives above mentioned, but concordant analyses established its composition as that represented by the formula $n(C_{20}H_{16}Cl_4O_{10})$ and, therefore, as closely similar also. The original black substance, further, on treatment with nitric acid, specific gravity 1·4, at 30° C., was attacked and dissolved to a red solution, which on dilution, deposited a yellow nitro-body as a copious flocculent precipitate.

These results clearly show—(1.) That the black substances formed from the carbo-hydrates by the action of sulphuric acid (below 100°), while they have the external characteristics of charcoal, are not carbonaceous in any more special sense than alcohol is. (2.) That under this action, cellulose is so modified as to resemble (in its derivatives) the compound obtained from liquefied fibres, and, therefore, until we have proof to the contrary, we may regard *lignin* as derived from cellulose by a simple chemical modification (? dehydration). (3.) That the study of these compounds will throw light upon the relationship between the two great groups of the carbo-hydrates and the aromatic compound, and, lastly, may be expected also to elucidate several points in connection with the origin and nature of coal. These are the questions which are at present occupying our attention.

ON THE PREPARATION OF PURE NAPHTHALEN.

By G. LUNGE, Ph.D., F.C.S., Professor of Technical Chemistry, Zürich.

The manufacture of pure naphthalen on a large scale and at a cheap rate is still considered a secret process, and is not known to many tar-distillers. Hence, I may hope, that a communication of a convenient process for this purpose may be welcome to many of your readers, and I am fully entitled to publish it, as I have found it quite independently, and as I am, indeed, not even aware whether the same, or a similar plan, is in use at those tar-works where pure naphthalen is prepared.

Everybody knows that even very white naphthalen turns pink in the air after some time; this tendency can be overcome only by repeated crystallisations, washings, distillations, &c. Now the manufacturers of naphthol require naphthalen as nearly as possible chemically pure, and regard as a principal criterion its keeping *permanently* white. On the other hand, so much and so cheap pure naphthalen, made by "secret" processes, is in the market that evidently no purifying process has any chance which is not very simple and inexpensive. When working at a treatise (now in the press) on coal-tar and ammonia, my attention was necessarily drawn to the above gap in our public knowledge, and it became my task to try filling it up, in which I succeeded very soon.

I started from the assumption that the discolouration of naphthalen is analogous to that of phenol, and that it may be caused by the difficulty of removing the last traces of phenol from naphthalen. Now perfectly pure phenol does not discolour, but it does so when containing traces of higher homologues, and when exposed to the air. The presence of traces of mineral acids seems to be another condition for the development of the pink colour. It may be that the latter influence causes the formation of aurin, thus:—

$$2C_6H_6O + C_7H_8O + 3O = 3H_2O + C_{19}H_{14}O_3;$$

but it is immaterial whether this or any other pink compound is formed. In any case it seemed possible to form at once, by previous oxidation, the substance which causes the gradual discolouration of phenol, or of naphthalen, and to separate it, if not volatile, by distillation so as to obtain permanently white products.

Starting from this idea, I tried the addition of an oxidising agent in the ordinary chemical washing of naphthalen, and I succeeded at once. Crude naphthalen is usually obtained from tar oils previously treated with alkali for the purpose of extracting the phenols, and in this case evidently the action of acids should commence the purifying operations; but if naphthalen, obtained direct from tar, were to be treated, the first operation should be washing with alkali. The crude naphthalen is fused with a certain quantity of sulphuric acid. Acid of 170° Tw. is best, and of this from 5 to 10 per cent will be required on the large scale, but even acid of 140° Tw., employed in a little larger quantity, will do very well. When the liquid naphthalen and the vitriol have been well mixed up together, 5 per cent of the weight of naphthalen of manganese dioxide is gradually added. Native manganese, well ground up, may be used, but recovered manganese (dried Weldon mud) is preferable. The mixture is heated on the water-bath till no further reaction takes place, say for 15 or 20 minutes. The acid is now drawn off, the naphthalen washed several times with hot water, then with weak caustic soda solution, and again with water. It proved unnecessary to repeat the acid treatment, or to employ strong alkali.

Evidently manganese dioxide may be replaced by any other oxidising agent, but I did not make any experiments thereon, as there was no hope of finding a cheaper agent. Even a current of air would not be much cheaper, but it would be hardly as efficient, and would carry away a good deal of naphthalen.

The naphthalen cake is now distilled, and nearly all can be collected within one or two degrees of the boiling-point of pure naphthalen. The distillation should be carried on on the small scale in a long-necked flask; on the large scale in a still provided with a dephlegmating column.

A sample of naphthalen prepared by me according to the above simple and cheap plan has already kept its pure white colour for eight or nine months, whilst all the samples of "chemically pure" naphthalen which I had obtained from the most celebrated manufacturers, and which were kept in the same glass case, have long since turned pink.

ASBESTOS STOPPER FOR COMBUSTION TUBES.

By J. FLEMING WHITE, Laboratory of U.S. Geological Survey.

Some years ago, when working in the laboratory of organic chemist of Harvard University, I conceived the idea of an asbestos stopper for combustion tubes, which I make as follows:—The asbestos is separated into fine threads, moistened with water, twisted into a plug, crowded into the cylinder of an ordinary steel crusher, such as is used to pulverise minerals for analysis, and compressed by driving the piston of the crusher down upon it with a hammer, or better, by the screw of a vice. The plug is kept under pressure for several hours, then dried within the cylinder upon a sand-bath, pushed out of the cylinder, and after ignition over a blast-lamp is ready for use.

In this condition the plug loses no weight under prolonged ignition, is elastic enough to make a tight joint when fitted to a combustion tube of suitable size, and may be smoothly perforated with an ordinary cork borer.

Besides simplifying the method of organic analysis by permitting the substitution of short metallic tubes for the long glass combustion tubes in ordinary use, asbestos stoppers are very useful for closing bottles which contain substances corrosive to stoppers of rubber or cork.—*American Chemical Journal.*

THE TITRATION OF TARTARIC, MALIC, AND CITRIC ACIDS WITH POTASSIUM PERMANGANATE.

PRELIMINARY NOTE.

Communicated by F. W. CLARKE.

Some time ago, in the course of certain investigations upon the tartrates of antimony, it occurred to me that tartaric acid, like oxalic acid, might, perhaps, be conveniently titrated with potassium permanganate. A single qualitative experiment showed that a fair end reaction was attainable, and the same thing proved to be true of malic and citric acids also. Accordingly I put the question into the hands of Mr. Miles Beamer, who made the following determinations:—

The titrations were performed in all essential particulars exactly as for oxalic acid. A solution was prepared containing a definite quantity of tartaric acid, and upon this the permanganate solution, which was approximately twentieth normal, was standardised. Sulphuric acid was of course added before titrating. The colour changes were rather slower than with oxalic acid, and required a somewhat higher temperature. They were also possibly a trifle less delicate, but still fairly concordant results were easily obtained.

Having standardised the permanganate solution, it was used for estimating the percentage of tartaric acid in sodium potassium tartrate, $C_4H_4KNaO_64H_2O$. The following was the result, reckoning the acid as $C_4H_4O_6$:—

Percentage found..	51·63
„ theoretical	52·48
Error	0·85

As this percentage was rather roughly determined, a fresh experiment was made, with a new and more carefully standardised permanganate solution.

$C_4H_4O_6$ found	52·75
Error	0·27

Two sets of titrations were also made upon hydrogen potassium tartrate, $C_4H_5KO_6$. The percentages of acid, reckoned as $C_4H_5O_6$, came out as follows:—

First set	79·20
Second set	78·88
Theory	79·25

Tartar emetic was treated as follows:—Its solution was mixed with a slight excess of ammonium sulphide, and then acidulated with dilute sulphuric acid. By warming and filtration, all the antimony was thus removed, and the tartaric acid was left in a suitable condition to be determined. The salt used, however, was found to have lost some of its crystalline water, so that the results were not comparable with theory. Other determinations are now in progress upon certain tartrates of antimony, and will be published in due time.

The experiments upon malic acid precisely resembled those upon tartaric acid, and were conducted by Mr. C. S. Evans. As we had no definite malates at hand, a standardised solution of malic acid was neutralised partly with caustic soda and partly with ammonia. Thus solutions of alkaline malates were obtained containing known quantities of acid. Upon titrating these solutions, it was found that they behaved exactly like the acid itself. The ammonium malate gave 99·89 per cent of the acid known to be present, while the sodium salt gave 100·007 per cent.

With citric acid the results are still very incomplete. Mr. L. R. Freeman standardised a solution of permanganate upon this acid, and found the final reaction to be fairly sharp, but very slow towards the end. This standard permanganate, applied to an analysis of trisodium citrate, gave in mean 53·36 per cent of acid, reckoned as $C_6H_5O_7$. The theoretical amount should be 52·94. Error, 0·42. Mr. Evans attempted a repetition of these experiments, but, for some unknown reason, was not successful.

These preliminary figures show fairly well that the permanganate solution is suited to the titrations in question. The results may not be as sharp as with oxalic acid, but still they are fairly good. Some comparative titrations by Mr. Freeman show that tartaric and malic acids are oxidised to carbonic acid and water, while with citric acid the result is, of course, more complex. Although, then, it may be possible to standardise the permanganate upon oxalic acid once for all, I suspect it is better to standardise it directly upon whichever acid is actually to be estimated. I hope that either Mr. Beamer or myself will be able soon to present some additional figures.—*American Chemical Journal.*

ON THE SOLUBILITY OF TRIBASIC CALCIUM PHOSPHATE IN AMMONIACAL SALTS AND IN NEUTRAL ALKALINE SALTS, FROM AN ANALYTICAL AND AGRICULTURAL POINT OF VIEW.

By M. A. TERREIL.

In 1862, I published a memoir on the mineral principles which water removes from vegetable substances by maceration, infusion, and decoction, showing that water, even cold, removes from such matters calcium and magnesium phosphates, although the solutions were perfectly neutral. I have been often concerned to know what matters aid in dissolving these insoluble compounds. Being persuaded that, as regards the absorption of phosphates by plants, there is an important point to elucidate, and rejecting the idea put forward that the introduction of these phosphates into plants is effected by means of free carbonic or acetic acids, I have for some time undertaken researches on the alkaline salts, and on neutral organic proximate principles, as serving to hold in solution the insoluble phosphates, and in particular the phosphate of lime, and I have undertaken to determine their solvent power in this respect.

My attention was first drawn to the ammoniacal salts by the following circumstance:—Wishing to determine the solvent power of citric acid as ammonium citrate upon calcium phosphate, I dissolved some of this phosphate in hydrochloric acid; I added a known weight of citric acid, supersaturated with a slight excess of ammonia, and after filtering off the precipitated calcium phosphate, I determined the phosphoric acid in the filtrate. On operating thus with equal weights of citric acid I obtained very different numbers, *e.g.*, 24·7 per cent of the weight of the acid in one case, and 13·4 per cent in another. But as I had not measured the quantities of hydrochloric acid employed for dissolving the phosphate, I thought these differences might depend on the solubility of the phosphates in all the ammoniacal salts in general.

Setting out with this idea I began a series of experiments on the solvent power of the different ammoniacal salts for calcium phosphate, operating as follows:—

I first prepared a very pure phosphate of lime in a gela-

tinous state, and I dissolved a certain quantity of this phosphate in a known weight of acid. I then saturated with ammonia till an alkaline reaction was perceived. I filtered, washed, and in the filtrate I determined the phosphoric acid remaining in solution as ammoniaco-magnesian phosphate. The lime was determined in the ordinary manner, the ammoniacal salts having first been expelled by heat.

On operating thus, and with different weights of acid, there is found apparently the same coefficient of solubility of calcium phosphate for 100 parts of acid employed, showing that the more ammoniacal salt is formed the more calcium phosphate remains in solution. This is a very important fact from an analytical point of view, and explains the differences noticed above as regards citric acid, differences which reappear, doubtless, in the commercial analyses of superphosphates.

The author then gives a table of the coefficients, which he has found for the principal acids, converted into ammoniacal salts. These numbers, for 100 parts of acid by weight, range from 0·225 for acetic acid to 6·95 for crystalline citric acid. These numbers are rather low, in consequence of the solubility of the ammonium-magnesian phosphate in ammoniacal salts, the exact proportion of which the author purposes to determine.

Calcium phosphate is also held in solution by the salts of potassium and sodium, but in a much less degree than by the ammoniacal salts.

The author purposes extending his researches so as to determine the solvent influence of sugars, gums, and other proximate organic principles upon calcium phosphate in neutral solutions.—*Bull. de la Soc. Chimique de Paris.*

ON DECIPIUM AND SAMARIUM.

By M. DELAFONTAINE.

On October 28, 1878, I had the honour of communicating to the Academy the discovery of a new metal from samarskite. At that time I fixed the molecular weight of decipia at about 122, and I described its absorption-spectrum. Since then the defective situation of my windows and other material obstacles have caused me to lay spectroscopic observations almost entirely aside, and I have confined myself to the chemical study of decipium. Without these difficulties the facts about to be laid down in this note would have occurred to me much earlier.

On submitting to methodic washings in cold water those of the earthy-sodic double sulphates of samarskite which are the least soluble in sodium sulphate, I obtained separations showing that my decipia of 1878 was in reality a mixture of two new oxides, one of them with a molecular weight of about 130, the other with a molecular weight notably lower. The former does not appear to give an absorption-spectrum, whilst the second gives that which I described two years ago.

No chemist has made known these facts before me. M. Lecoq has, indeed, subsequently announced the discovery of samarium, but he had in his hands merely a mixture like mine. I consider myself, therefore, entitled to name these two new elements.

As in my memoir published in the *Archives des Sciences Physiques et Naturelles*, March, 1880, I will retain the name decipium for the radicle of the earth which has the molecular weight of about 130. In this memoir it is merely requisite to cancel the paragraph treating of the absorption-spectrum. Now, as a year ago dry decipium sulphate gives 61·4 per cent of earth (the mean of four analyses made upon quantities comprised between 2·5 and 8 grms.), three analyses of acetate give 45·03, and two of formiate 63·56 per cent. The salts are colourless, and their solubility is identical.

In order the better to utilise the good description of the absorption-spectrum of the other metal, published by M. Lecoq, I propose to transfer to it the name samarium. The molecular weight of samaria does not exceed 117, and is probably lower. In equal concentration its solution gives absorption-bands more intense than those of the original specimen of 1878, the equivalent of which was 122.

In May, 1880, M. Marignac described two of the earths of samarskite, distinguishing them as Yα and Yβ. The latter, to which the Genevese *savant* attributes the equivalent 115, seems to me identical with samaria. As to the former (Yα = 120·5) it may be supposed a mixture of decipia and terbia. I have a few grammes of it, but its study is not sufficiently advanced to warrant the assertion that it is not a distinct species.—*Comptes Rendus.*

INDIGO, AND ITS ARTIFICIAL PRODUCTION.*

By H. E. ROSCOE, LL.D., F.R.S., &c.
President of the Chemical Society.

(Continued from p. 54.)

Step No. 3.—The next advance of importance in this somewhat complicated matter is the discovery by Erdmann and Laurent independently, that indigo on oxidation yields a crystalline body, which, however, possesses no colouring power, to which they gave the name of isatin.

$$\underset{\text{Indigo.}}{C_8H_5NO} + O = \underset{\text{Isatin.}}{C_8H_5NO_2}.$$

Step No. 4.—The reverse of this action, viz., the reduction of isatin to indigo, was accomplished by Baeyer and Emmerling in 1870 and 1878, by acting with phosphorus pentachloride on isatin, and by the reducing action of ammonium sulphide on the chloride thus formed.

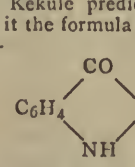
Understanding now something of the structure and of the relationships of the body which we wish to build up, let us see how this edifice has, in fact, been reared. Three processes have been successfully employed for carrying out this object. But of these three only one is of practical importance. A synthetic process may yield the wished-for result, but the labour incurred may be too great and the losses during the campaign may be too severe to render it possible to repeat the operation with advantage on a large scale. Just as it costs, at the usual rate of wages, more than twenty shillings to wash a sovereign's worth of gold out of the Rhine sands, so that this employment is only carried on when all other trades fail.

For the sake of completeness, let us, however, consider all three processes, although Nos. 1 and 2 are at present beyond the pale of practical schemes.

These three processes have certain points in common. (1) They all proceed from some compound containing the benzene nucleus. (2) They all start from compounds containing a nitrogen atom. (3) They all commence with an ortho-compound.

They differ from one another, inasmuch as process No. 1 starts from a compound containing 7 atoms of carbon (instead of 8), and to this, therefore, one more atom must be added; process No. 2, on the other hand, starts from a body which contains exactly the right number (8) of carbon atoms; whilst No. 3 commences with a compound in which 9 atoms of carbon are contained, and from which, therefore, 1 atom has to be abstracted before indigo can be reached.

Process No. 1 (Kekulé—Claissen and Shadwell).—So long ago as 1869 Kekulé predicted the constitution of isatin, and gave to it the formula which we now know that it possesses, viz.,—



* A Paper read before the Royal Institution of Great Britain, Friday, May 27, 1881.

Following up this view, Claissen and Shadwell, two of Kekulé's pupils, succeeded in preparing isatin, and, therefore, now indigo, from ortho-nitro-benzoic acid.

The following are the steps in the ascent :—

1. Ortho-nitro-benzoic acid acted on by phosphorus pentachloride yields the chloride, $C_6H_4(NO_2)COCl$.
2. This latter heated with silver cyanide yields the nitril, $C_6H_4(NO_2)CO.CN$.
3. On heating this with caustic potash it yields ortho-nitro-phenyl-glyoxylic acid, $C_6H_4(NO_2)CO.CO_2H$.
4. This is converted by nascent hydrogen into the amido-compound, $C_6H_4(NH_2)CO.CO_2H$.
5. And this loses water and yields isatin,—

$$C_6H_4NH.CO.CO.$$

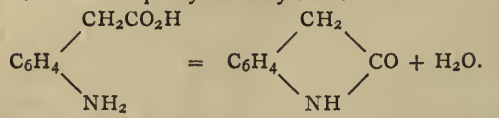
(Q. E. D.)

The reasons why this process will not work on a large scale are patent to all those who have had even bowing acquaintance with such unpleasant and costly bodies as phosphorus pentachloride or cyanogen.

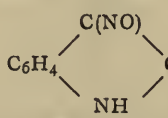
Process No. 2.—Baeyer's (1878) synthesis from ortho-nitro-phenyl-acetic acid.

This acid can be obtained synthetically from toluol, and it is first converted into the amido-acid, and which, like several ortho-compounds, loses water, and is converted into a body called oxindol, from which isatin, and, therefore, indigo, can be obtained. The precise steps to be followed are :—

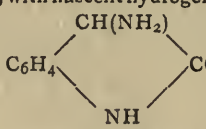
1. Ortho-amido-phenyl-acetic yields oxindol :



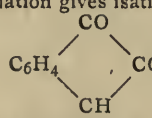
2. This on treatment with nitrous acid yields nitros-oxindol :



3. This, again, with nascent hydrogen gives amidoxindol :



4. Which on oxidation gives isatin :



(Q. E. D.)

This process, the feasibility of which had also been foreseen by Kekulé, is, however, not available as a practical scheme, for various reasons.

Process No. 3.—This may be called the manufacturing process, and was also proposed by Baeyer. It starts from cinnamic acid, a substance contained in gum benzoin, balsam of Peru, and some few other aromatic bodies. These sources are, however, far too expensive to render this acid thus obtained available for manufacturing purposes. But Bertagnini, in 1856, had obtained cinnamic acid artificially from oil of bitter almonds, and other processes for the same purpose have since been carried out. Of these, that most likely to be widely adopted is the following practical modification by Dr. Caro of Mr. Perkin's beautiful synthesis of cinnamic acid :—

1. $C_6H_5CH_3 + 4Cl = C_6H_5CHCl_2 + 2HCl$.
   Toluene. Benzylene Dichloride.
2. $C_6H_5CHCl_2 + 2CH_3.CO.O.Na =$
   Benzylene Dichloride. Sodium Acetate.
   $= C_6H_5CH{=}CH.CO.OH + 2NaCl$.
   Cinnamic Acid.

But why did Baeyer select this 9-carbon acid from which to prepare indigo ? For this he had several reasons. In the first place, it had long been known that all indigo compounds when heated with zinc dust yield indol, C_8H_7N, a body which stands therefore to indigo in the same relation as anthracen to alizarin, and Baeyer and Emmerling had so long ago as 1869 prepared this indol from ortho-nitro-cinnamic acid thus :—

$$C_8H_6(NO_2)CO_2H = C_8H_7N + O_2 + CO_2.$$

Secondly, the ortho-nitro-cinnamic acid required (for we must remember that indigo is an ortho-compound and also contains nitrogen) can be readily prepared from cinnamic acid, and this itself again can be obtained on a large scale. Thirdly, this acid readily parts with 1 atom of carbon, and thus renders possible its conversion into 8-carbon indigo.

The next steps in the process are (3) the formation of ortho-nitro-cinnamic acid, (4) the conversion of this into its dibromide, (5) the separation from this of the two molecules of hydrobromic acid, giving rise to ortho-nitro-phenyl-propiolic acid, and (6) lastly, the conversion of this latter into indigo by heating its alkaline solution with grape sugar, xanthate of soda, or other reducing agent. These reactions are thus represented :—

3. $C_6H_5CH{=}CHCOOH \quad C_6H_4(NO_2)CH{=}CH.COOH$
   Cinnamic Acid yields Ortho-nitro-cinnamic Acid.

In this process the para-acid is also obtained, and as this is useless for the manufacture of indigo, it has to be removed. This is effected by converting the acids into their ethyl-ethers, which, possessing different degrees of solubility, can be readily separated from one another.

4. This is next converted into the dibromide,

$$C_6H_4(NO_2)CHBr.CHBrCOOH.$$

5. And by careful treatment with caustic soda this yields ortho-nitro-phenyl-propiolic acid, thus :—

$$C_6H_4(NO_2)CHBrCHBrCOOH + 2NaOH =$$
$$= C_6H_4(NO_2)C_2.COOH + 2NaBr + 2H_2O.$$

6. $n[C_6H_4(NO_2)C_2.COOH + H_2 = C_8H_5NO + CO_2 + H_2O]$.
   Ortho-nitro-phenyl-propiolic Acid. Indigotin.

(Q. E. D.)

The last of these reactions is in reality not so simple as the equation indicates. For only about 40 per cent of indigo is obtained, whereas according to theory 68 per cent should result. Indeed, although, as we have seen, indigo can be prepared by these three methods, chemists are as yet in doubt as to its molecular weight, the probability being that the molecule of indigo contains twice 16 atoms of carbon, or has the formula $4(C_8H_5NO)$ or $C_{32}H_{20}N_4O_4$. Still it must be remembered that according to Sommaruga the vapour-density of indigo is 9·45, a number corresponding to the simpler formula $C_{16}H_{10}N_2O_2$.

The artificial production of indigo may even now be said to be within reasonable distance of commercial success, for the ortho-nitro-phenyl-propiolic acid, the colourless substance which on treatment with a reducing agent yields indigo-blue, is already in the hands of the Manchester calico printers, and is furnished by the Baden Company for alkali and aniline colours at the price of 6s. per lb. for a paste containing 25 per cent of the dry acid.

With regard to the nature of the competition between the artificial and the natural colouring matters it is necessary to say a few words. In the first place, the present price at which the manufacturers are able to sell their propiolic acid is 50s. per kilo. But 100 parts of this can only yield, according to theory, 68·58 parts of indigo-blue, so that the price of the artificial (being 73s. per kilo.) is more than twice that of the pure natural colour. Hence, competition with the natural dyestuff is not to be thought of until the makers can reduce the price of dry propiolic acid to 20s. per kilo., and also obtain a theoretical yield from their acid. This may, or it may not, be some day accomplished, but at present it will not pay to produce indigo from nitro-phenyl-propiolic acid. Nevertheless, a large field lies open in the immediate future for turning

Baeyer's discovery to practical account. It is well-known that a great loss of colouring matter occurs in all the processes now in use for either dyeing or printing with indigo. It has already been stated that a large percentage of indigo is lost in the "cold vats" in the sediment. Another portion is washed off and wasted after the numerous dippings, whilst in order to produce a pattern much indigo must be destroyed before it has entered into the fibre of the cloth. Moreover, the back of the piece is uselessly loaded with colour. In the processes of printing with indigo the losses are as great, or even greater, and, in addition, such considerable difficulties are met with that only a few firms (Potter, Grafton in Manchester, and Schlieper in Elberfeld) have been successful in this process. But a still more important fact remains, that no printing process exists in which indigo can be in combination with other colours in the ordinary way, or without requiring some special mode of fixing after printing. Hence it is clear that the weak points of natural indigo lie in the absence of any good process for utilising the whole of its colouring matter, and in the impossibility, or at any rate great difficulty, of employing it in the ordinary madder styles of calico printing. Such were the reasons which induced the patentees to believe that although the artificial dye cannot be made at a price to compete with natural indigo for use in the ordinary dye-beck, it can even now be very largely used for styles to which the ordinary dyestuff is inapplicable.

To begin with, Baeyer employed (Patent 1177) grape-sugar as a reducing agent. The reduction in this case does not take place in the cold, and even on long standing only small traces of indigo are formed, but if heated to 70° or upwards the change takes place. Unfortunately this production of indigo-blue is rapidly followed by its reduction to indigo-white, and it is somewhat difficult in practice to stop the reaction at the right moment. But "necessity is the mother of invention," and Dr. Caro, of Mannheim, to whom the speaker is greatly indebted for much of the above information, found that sodium xanthate is free from many of the objections inherent to the glucose reduction process, inasmuch as the reaction then goes on in the cold. Moreover, he finds that the red isomeride of indigo-blue, Indirubin, which possesses a splendid red colour, also occurring in natural indigo, but whose tinctorial power is less than that of the blue, is produced in less quantity in this case than when glucose is employed. On this cloth alumina and iron mordants may be printed, and this afterwards dyed in alizarin, &c., or this colouring matter may also be printed on the cloth and the colour fixed by moderate steaming without damage to the indigo-blue. This process is now in actual use by printers both in England and on the Continent, so that, thanks especially to the talent and energy of Dr. Caro, Baeyer's discovery has been practically applied within the short space of twelve months of its conception. Operations on a manufacturing scale have been successfully carried on in the Baden Soda and Aniline Works at Ludwigshafen for the last two months, and the directors see no reason why they should not be able to supply any demand, however great, which may be made for ortho-nitro-phenyl-propiolic acid.

The proper way of looking at this question at present is, therefore, to consider ortho-nitro-phenyl-propiolic acid and indigo as two distinct products not comparable with each other, inasmuch as the one can be put to uses for which the other is unfitted, and there is surely scope enough for both. Still, looking at the improvements which will every day be made in the manufacturing details, he must be a bold man who would assert the impossibility of competition with indigo in all its applications. For we must remember that we are only at the beginning of these researches in the indigo field. Baeyer and other workers will not stay their hands, and possibly other colouring matters of equal intensity and of equal stability to indigo may be obtained from other as yet unknown or unrecognised sources, and it is not improbable that these may turn out to be more formidable competitors in the race with natural indigo than ortho-nitro-phenyl-propiolic acid.

Looking at this question of the possible competition of artificial with the natural indigo from another point of view, it must, on the other hand, be borne in mind that the present mode of manufacturing indigo from the plant is extremely rude and imperfect, and that by an improved and more careful carrying out of the process great saving in colouring matter may be effected, so that it may prove possible to produce a purer article at a lower price, and thus to counterbalance the production of the artificial material.

(To be continued.)

NOTICES OF BOOKS.

The Chemistry of the Farm. By R. Warington, F.C.S. London: Bradbury, Agnew, and Co.

The author of this work gives as a special reason for its appearance "the scarcity of books on farm chemistry in the English language." He considers that we have no text-books in which "the present aspects of the science are at all adequately represented."

We cannot entirely accept Mr. Warington's contention. We will admit that the agricultural treatises of Davy, and even of Liebig, are now no longer of special use to the student, what in them was of value having been reproduced in later works. But an edition of Prof. Johnston's "Agricultural Chemistry," brought down to the present state of knowledge, has appeared at no very remote date. We find also that our author has forgotten the existence of a book by M. Ville, embodying the results of a long series of important experiments. This omission is the more striking, as the work in question has appeared in an English version.

Still we cheerfully admit that manuals of agricultural chemistry have not yet, like elementary treatises on general chemistry, multiplied to such an extent as to become little short of a nuisance.

The work before us is of such a nature that it might perhaps claim the title "The Physiology of the Farm" quite as legitimately as that which it actually bears. Agriculture, however, is undoubtedly based upon physiology not less than upon chemistry in the true sense of the term.

One of the first points which strike us on a close examination of Mr. Warington's treatise is a tendency to repetition. Thus, on page 4 we read that plants obtain "through the instrumentality of their leaves the whole, or nearly the whole, of their carbon, with probably small quantities of nitrogen and water." On page 6 it is again stated that "plants are apparently capable of absorbing a small quantity of ammonia through their leaves;" and on page 13 we are told "that the ammonia of the air is directly absorbed by plants to a very small extent." In one passage the reader learns (page 8) that "most plants are unable to assimilate the nitrogenous humus contained in soil," whilst on page 17—possibly with a view to the old saying, *Repetitio mater est studiorum*—comes the very similar proposition, "The nitrogen contained in humus is not in a condition to serve as a general plant food."

Silica was till lately considered as an essential portion of the food of cereals, and indeed of grasses generally, forming the beautiful surface-glaze which was supposed needful for the stability of the stems. In four distinct passages the author more or less explicitly shows that it is non-essential, and that the silicated glaze aforesaid is a mere excretion. Further instances of similar repetitions might be given if at all necessary.

On page 10 we find the assertion that certain seeds, such as linseed, "contain no starch, but in its place a large quantity of fat." The presence of fat in linseed is of course very evident, but on referring to published ana-

lyses, both of the crude seed and of the cake after expression, we find that a small quantity of starch is present.

"Phosphoric acid, potash, and ammonia," we read, "are very rarely found in drainage water." Some good authorities on the analysis of waters maintain that phosphoric acid is almost universally detected where carefully sought for. But, leaving this point aside, the absence of ammonia in drainage-water is due not so much to its retention in the soil as to its conversion into nitrates.

As exceedingly valuable we must call attention to certain ideas on the characteristics of crops which the author ascribes to Mr. Lawes. This distinguished experimentalist points out that the active growth of the cereals extending only to the end of June places these crops at a disadvantage as far as the supply of nitrogen from nitrates present in the soil is concerned. The nitrates formed in the soil during the foregoing season are generally washed away by the winter rains before the active growth of the corn commences, and by the time nitrification is well resumed in the summer cereal crops are too mature to appropriate fresh supplies of nitrogen. Hence continuous wheat crops impoverish the soil in nitrogen to a greater extent than by the quantity actually assimilated by the plant. On the other hand, green crops which continue growing into the autumn utilise the nitrates formed during the summer, and do not leave it to be washed away.

This work contains much valuable instruction, and if freed from repetitions such as we have pointed out, and from an occasional ambiguity of expression, would prove very useful.

The Harrogate Waters: Data, Chemical and Therapeutical, with Notes on the Climate of Harrogate. By G. Oliver, M.D. London: H. K. Lewis.

There are many persons who consider the benefits of leaving town during the summer to consist, not so much in a temporary relief from the noise and worry of their ordinary life, as in a "change of air." Accordingly, they select their resorts, not so much on account of varied and picturesque scenery, as in accordance with some trifling difference of climate, such as temperature, atmospheric moisture, &c, or with a trifling difference in the death rate. Among the peculiarities of Harrogate we find here enumerated the absence of forests. If this feature is an advantage at all it is one common to at least nine-tenths of the surface or the British Islands. We cannot help remarking that, in warmer climates at least, the extirpation of the forests has proved by no means conducive to health, and that replanting has been advocated no less on sanitary than on agricultural grounds.

Mineral waters are found in this breezy—or as some persons would call it, bleak and bare—district in considerable variety. There are pure sulphur waters, saline sulphur waters, pure chalybeates, saline chalybeates, and sulphuretted chalybeates. A feature, by no means common, is the presence of barium and strontium chlorides. According to Prof. Thorpe—an unimpeachable authority—no mineral springs, either in this country or on the Continent, contain so large a proportion of this substance as the Harogate waters. He found in the "Old Sulphur Spring," in 1875, no less than 0·820 gr. barium chloride per pint. He considers that the proportion of this salt is increasing, and in view of its well-known therapeutic activity, recommends that the proportion should be from time to time re-determined. The largest amount of strontium chloride, 0·418 gr. per pint, is in the "Strong Montpellier Spring." As a matter of course, soluble sulphates are absent. The calcium salts present are the carbonate, and especially the chloride. But the total average of lime in the Harrogate aperient waters is only 9 per cent as against 21 per cent in the Kissengen springs. In none of the Harrogate waters are sulphates—especially calcium sulphate, which the author pronounces indigestible and constipating—present in more than a mere trace.

The sulphur present exists in combination with hydrogen and with sodium. With the sole exception of Challes, the "Strong Sulphur" contains more sodium sulphide than exists in any known water.

Iodine and bromine have been discovered by Prof. Thorpe in the "Old Sulphur Spring," the former in the proportion of 0·0146 and the latter 0·2805 in 10,000 parts. Chloride of manganese has also been detected in one of the chalybeate wells. Arsenic is not recorded as occurring in any of the waters.

Into the second portion of the work, the therapeutic examination of the Harrogate Springs, it is not our province to enter. It may, however, be fairly asked whether the large importation of foreign mineral waters which the turn of fashion and a course of diligent advertising have brought about is really essential?

CORRESPONDENCE.

ON A NEW METHOD FOR THE ESTIMATION OF NITRATES IN POTABLE WATERS.

To the Editor of the Chemical News.

Sir,—Allow me to inform Mr. West Knights that his process for the estimation of nitrates is not the only one that has been devised for the estimation of nitric acid based on the brucine reaction, and that his statement—viz., such a process has never been given—is very premature. Mr. Knights will also find that his standard red solution is liable to decompose if it does not contain alcohol; it also requires to be kept from the light.—I am, &c.,

William Johnstone.

King's Lynn, July 29, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 26, June 27, 1881.

Use of Liquid Prisms in Direct Vision Spectroscope.—C. V. Zenger.—The author employs a mixture of anethol and benzol. Its absolute dispersion is 3·7 times that of quartz.

Photography of Colours by Dyeing Layers of Coagulated Albumen.—C. Cros and J. Carpentier.—The authors submitted to the Academy two photographic proofs of a painting in water colours, along with the original, showing the exact reproduction of the details and colours. Three photographs of the object are taken respectively through liquid screens of an orange, a green, and a violet colour. For the image obtained through the green screen there is employed a red colour bath, for that produced through the orange screen a blue, and for the image of the violet screen a yellow bath. In this process there is not a direct photographic reproduction of images with the natural colours of the bodies.

Silicium.—P. Schützenberger and A. Colson.—Crystalline silicium heated almost to whiteness in an atmosphere of carbonic acid absorbs this gas rapidly, and is ultimately converted into a greenish white mass. On being freed from unchanged silicium by treatment at a boil with moderately concentrated potassa lye, the residue is found partially soluble in hydrofluoric acid, which dissolves silica and leaves a residue, which, when washed and dried, is a greenish powder, not attacked by boiling alkaline lyes

or by acids, including the hydrofluoric. If heated to redness in a current of oxygen it is little modified, and yields carbonic acid, corresponding only to 2 or 3 per cent of carbon. But if heated to dull redness with lead chromate and litharge it becomes incandescent, and evolves notable quantities of carbonic acid. On analysis it is found to contain 21·4 per cent of carbon. The silicium nitride of Wœhler contains also carbon. Hence the authors admit the existence of a tetratomic radicle, carbosilicium, which, like carbon, yields a binoxide and a nitride. On heating the product of the action of dry ammonia upon silicium chloride in a current of hydrogen, the authors obtained a white powder, $Si_5N_6Cl_2$. If this powder is heated to redness in a current of ammonia it loses all its chlorine in the form of hydrochloric acid, and leaves a residue, Si_2N_3.

A Cyanic Ether of Borneol.—A. Haller.—If melted with potassa the borneol cyanate is decomposed, yielding camphol, potassium carbonate, and ammonia. Its solution in absolute alcohol, heated with potassa, yields on cooling potassium cyanate. If heated to 200° to 210° it is split up into borneol and cyanuric acid.

Part Played by Phosphoric Acid in Volcanic Soils.—L. Ricciardi.—A reply to a memoir presented to the Academy by M. de Gasparin, June 6th.

Bulletin de la Société Chimique de Paris.
No. 4, February 20, 1881.

Potassium and Ammonium Tetra-chromates.—G. Wyrouboff.—The author shows that the potassium nitrobichromate and nitro-trichromate of Darmstædter are in reality one and the same compound, a potassium tetrachromate.

Russian Chemical Society.—Session May 1/12, 1880.—The Secretary read an obituary notice of M. Wischnegradsky.

M. Louguinine communicated the continuation of his researches on the combustion-heats of organic compounds, and especially of isomeric bodies. He has particularly studied the amylic alcohol of fermentation, dimethyl-ethyl carbinol, and œnanthol.

M. Potilitzine gave an account of his investigations on the displacement of the chlorine in potassium chloride by bromine in an atmosphere of nitrogen. With reference to the memoir of M. Berthelot on the same subject (*Comptes Rendus*, 90, p. 893), he considers that the displacement of chlorine by bromine cannot be ascribed to any fortuitous cause whatever, and that its reason must be sought in the very nature of the reacting bodies.

M. Almedingen communicated an analysis of stibine found in the district of Birsk.

MM. Beilstein and Jawein indicated a method of determining zinc and zinc powder, based upon the determination of the hydrogen evolved when the metal is dissolved in hydrochloric acid.

M. Beilstein presented some observations on the properties of platinum crucibles.

M. Sokoloff described the result of the analysis of the mineral waters of Staraja-Roussa.

M. Orloff sent in a memoir on the determination of mercury in the bodies of animals poisoned with corrosive sublimate.

M. Mokoonsoff gave in researches on the determination of arsenic in animals which had been submitted to sudden or slow poisoning.

M. Bartholomeeff sent in a paper on the comparison of the process of MM. Wœhler and Siebold for the destruction of organic tissues with the process of Fresenius and Babo when it is required to determine antimony in a poisoned animal.

M. Konowaloff on causing nitric acid of sp. gr. 1·3 to react upon iso-tributylene, obtained a body which, on reduction, furnished an amine.

M. Kajander has studied the speed of the dissolution of magnesium in acids.

M. Chrapowicki presented to the Society the crystals of a new saturated hydrocarbon obtained by causing metallic sodium to react upon an ethereal solution of the iodide of tertiary butyl.

M. Lwow treated on the influence of iodine, water, carbonic acid, and some other bodies on the polymerisation of vinyl bromide exposed to light.

The same author gave an account of the action of chlorine and bromine on two isomeric quintanes, tetramethyl-formen, and dimethyl-ethyl-formen. To take date he also announced that he had obtained an amylen bromide, boiling at 110° to 115°.

M. Lagermark explained the principal results of researches on tetrolic acid.

M. Flavitzky announced that commercial oil of citron contains, along with dextro-rotatory terebenthen, more than 10 per cent of a lævo-rotatory terebenthen.

Red Dyeing with Artificial Alizarin.—M. Maurice Prud'Homme.—Inserted at length.

Die Chemische Industrie.
No. 1, January, 1881.

Determination of Potassium Sulphate in Kainite.—Dr. H. Precht.—The author proposes an indirect method, useful in all cases, where time is an object. He finds that for an increase of 1 per cent chlorine there is a decrease of 0·76 per cent potassium sulphate. He dissolves 10 grms. finely ground kainite in 500 c.c. of water, and titrates 20 c.c. of the unfiltered solution with decinormal silver nitrate. If 24 c.c. of the solution are consumed the sodium chloride present is 15·17 per cent, and the potassium sulphate 29·33. If the c.c. of silver solution taken rise to 34, the sodium chloride is 34·32, whilst the potassium sulphate falls to 22·52 per cent.

No. 2, February, 1881.

Certain New Products of the Alkali Manufacture.—Dr. Rammelsberg.—Certain colourless crystals obtained from the so-called red liquor have the same composition as crystals formed by treating disodium phosphate and caustic soda with sodium fluoride, and may be represented as $NaF+2Na_3PO_4$. The red vanadiferous crystals dissolve in water without colour, depositing a little iron sulphide. The solution gives with salts of silver a yellow precipitate containing phosphorus and vanadium, traces of chlorine and sulphur, carbonic acid, fluorine, and silica. The presence of phosphorus, vanadium, and fluorine in black-ash is due to the lime-stone and coal, and to the bricks of which the furnace is constructed. The clay used for fire-bricks often contains vanadium. In a second communication, Dr. Rammelsberg describes artificial Gay-Lussite, $Na_2CO_3+CaCO_3+5$ aq., produced in the carbonating towers. These crystals are produced when a large excess of lime is used in the manufacture of alkali. —*Monathsber, d. König. Acad. Wissen. Berlin.*

No. 3, March, 1881.

Loss of Soda in the Alkali Manufacture.—Dr. C. Reidemeister.—This paper treats mainly on the formation of sodium-calcium carbonate (artificial Gay-Lussite). The author concludes that the temperature at which sodium carbonate is formed in the Leblanc process is rather below the point at which calcium carbonate and sodium carbonate melt together.

Archives Neerlandaises des Sciences Exactes et Naturelles.
Tome xv., Livraison 3me.

This number contains no chemical or physical matter.

Tome xv., Livraison 4me.

The Composition of the Hydrates of Stannic, Manganic, and Silicic Oxides.—J. M. Van Bemmelen.—The author undertakes to show that the composition of

these compounds depends, first, on the degree of moisture and on the temperature of the ambient medium, and consequently on their own vapour-tension at each temperature, and, secondly, on their molecular state, ordinarily termed their allotropic state or condition. He shows that the composition of meta-stannic and stannic acids is not constant, even under ordinary circumstances. Silicic acid retains water with less force than stannic acid. M. Van Bemmelen thinks that of the maximum quantity of water which an oxide can retain at a given temperature different portions are fixed with a different force. In a dry medium the portion combined with a greater force is retained, whilst a portion united by a feebler force escapes. The case may occur that the number of molecules of an oxide is greater than that of the molecules of water retained. The water linked with less force is anew absorbed in the moist medium, and an equilibrium is established, when in a unit of time as many molecules enter as are given off. To each temperature there must correspond for each degree of moisture in the medium a different state of equilibrium, that is, a different composition of the hydrate. The connection is consequently a phenomenon of dissociation. At each temperature and at each degree of humidity the hydrates of stannic and manganic oxides and silicic acid have a given dissociation-tension.

Tome xv., Livraison 5me.

Combinations of Certain Solid Hydrates of Dioxides with Acids, Salts, and Alkalies.—J. M. Van Bemmelen.—The author seeks to demonstrate that certain phenomena are wrongly excluded from the domain of chemistry properly so-called and spoken of as cases of adhesion, absorption, retention, &c. A series of experiments on the behaviour of the amorphous hydrates of oxides with solutions of salts, acids, and alkalies has led him to conclude that the bulk of such phenomena enter into the general class of phenomena presented by feeble chemical combinations, and that these apparently irregular facts are governed by constant laws. The starting point for these researches was furnished by the results of a former investigation on the absorptive power of vegetable mould and silicic acid upon solutions of salts. If in such phenomena feeble chemical affinity is concerned, we shall find that the ultimate result will vary according to the relative proportions of silicic acid and of dissolved matter, and according to the concentration of the liquid. Other amorphous hydrates, *e.g.*, those of the oxides of tin, manganese, aluminium, iron, titanium, &c., will behave in an analogous manner. On comparing together various hydrates of oxides, or various modifications of one and the same hydrate, the phenomena of absorption will be found more pronounced in some than in others; transitions will be discovered between these phenomena and those of ordinary chemical combination, and other acids, bases, or salts may be substituted for the acids, bases, or salts absorbed. All these deductions, the author shows, have been confirmed by experiment.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. January, 1881.

Process of M. Baeyer for the Artificial Preparation of Indigotin.—M. Rosenstiehl.—After giving an account of the researches of Baeyer, the author stated that by means of ortho-nitro-phenyl-propiolic acid indigotin may be formed directly upon the tissue. He produced a piece of calico upon which had been printed a mixture of gum-water, containing the above-mentioned acid along with carbonate of soda and glucose. The design is scarcely visible at first, all the substances being colourless. But if the cloth is exposed for two minutes to a temperature bordering upon 100°, the design appears, and the formation of indigotin is so plentiful that the colour appears black. Washing with water removes the soluble matter, and indigo-blue becomes visible with all its characters, and is intimately fixed upon the fibre. This formation, so neat and rapid, is of undoubted interest in tissue-printing. Many attempts have lately been made to introduce indigo-blue in the composition of polychromic designs in fast colours, but the effects obtained have not been quite satisfactory. Possibly Baeyer's process may effect the solution of the question. The phenyl group contained in indigotin admits of numerous substitutions without the molecule losing its property of being a colouring-matter.

February, 1881.

Report delivered by M. Aimé Girard on Behalf of the Committee of Chemical Arts on the Machines for Casting Candles, Invented by M. Paul Morase.—This invention, though relating to one of the chemical arts, is of a purely mechanical nature.

Report given in by M. Troost on Behalf of the Committee of Chemical Arts on the Process for the Manufacture of Vinegar, Imported into France by M. Barbe.—The process is a modification of the "quick vinegar process" used in Germany. A number of casks containing beech-wood shavings and a mixture of alcohol, water, and the product of the fermentation of sugar-cane treacle are made to revolve horizontally six times daily.

March, 1881.

This number contains no chemical matter.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. February, 1881.

This number, as usual, contains no chemical matter.

April, 1881.

Appreciation of Patents Granted in Germany (XIII., Class 22, Tar Colours).—Dr. W. Weyl, of the German Patent Office.—A very interesting essay, the reproduction of which is, as usual, expressly prohibited.

Decree of the Ministry on the Method of Writing Numbers.—It is formally decreed that the comma is to be exclusively used as a decimal-point.

May, 1881.

Spontaneous Oxidation of Manganous Hydroxide, with especial Reference to Weldon's Process for the Regeneration of Manganese.—Jul. Post.—Reproduction prohibited, as usual.

Le Génie Civil.

Tome 1, No. 7, February 1, 1881.

The Use of Nitrous Sulphuric Acid in the Disinfection of Gases.—P. P. Dehérain.—This process, devised by MM. Girard and Babst for the utilisation of chamber crystals, has been already noticed.

No. 9, March 1, 1881.

Cremation.—Dr. de Pietra Santa.—An account is given of experiments performed with the furnace of Cadet, that of Müller and Fichet, and that of M. de Lagènardière. In Italy cremation appears to have made very considerable progress.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soft Soap.—Can any of your readers inform me whether soda-ash is now used instead of potash in making soft soap, and if so, how the soda-ash lees are prepared?—A Reader.

Soap Making.—If not troubling you too much, I will inquire through your valuable paper the method of separating the *resin* from the fat in commercial soaps, also how to estimate the amount of *resin* which invariably exists in commercial soaps.—J. R.

THE CHEMICAL NEWS.

Vol. XLIV. No. 1133.

ON A CURIOUS ACTINIC PHENOMENON.

(Second Note.)

AND ON THE QUESTION OF THE PRESENCE OF A NEW METALLIC ELEMENT IN COMMERCIAL ZINC.

By Dr. T. L. PHIPSON, F.C.S., &c.

In my first communication on this subject (Chemical News, vol. xliii., p. 283) I endeavoured from the results of a certain number of observations to give an explanation of it. I have now satisfied myself that the darkening of the white zinc pigment under the influence of light is really due to *reduction*, and that it returns to its former white colour, when placed in the dark, by a process of *oxidation*.

A certain quantity of the white substance is spread as thinly as possible over a flat surface and exposed to the morning sun. In about twenty minutes it has changed from pure white to a much darker tint, and in two hours it is as dark as slate. In this state it is scraped off, and placed in a very small hermetically sealed bottle, which is removed to a dark place. Half of the darkened specimen is also placed in the dark, but unprotected from the air. The latter, sooner or later, becomes quite white, whilst that which is enclosed remains a dark slate colour. When air is allowed access to the little bottle its contents gradually assume a white colour also.

This proves conclusively that by exposure to the sunlight a reduction occurs, which is changed into oxidation as soon as the product is placed in the dark. The question now remains: *What is the substance present in the white zinc pigment which causes this phenomenon?* In endeavouring to answer this question I must observe that—

(1.) The substance is originally quite white.

(2.) It is changed under the influence of sunlight, first, to a light fawn colour, which soon darkens, and gradually acquires a dark slate colour.

(3.) This effect is hindered to a *very great* extent by covering the white pigment with a piece of glass, so much so that *photographs can be produced* readily by the presence of this transparent medium. This action of glass is very remarkable: the light of day which filters through the windows of the laboratory is not capable of darkening the pigment after an exposure of eight months—the discolouration is only slight—it is necessary to place the white substance outside the window in order to observe the action of light upon it. A piece of glass placed directly upon a thin layer of the white substance cuts off the action of light almost as effectually as an opaque piece of cardboard. Vapour of water and atmospheric air act in the same manner as glass. Thus the actinic action is much less energetic in the afternoon when the sun is nearing the horizon than in the morning, and it is also less developed when the wet and dry thermometers register near together.

(4.) The phenomenon is due to a *reduction* which, when the substance is removed to the dark, becomes an *oxidation*, and the pigment is then restored to its original whiteness.

(5.) Pyrogallic acid facilitates the reduction (and causes it to proceed *to a certain extent* under glass), and when employed in rather large quantity makes the dark colour produced permanent for a length of time in the dark.

(6.) The dark product is soluble in acetic acid, which allows it to be separated from the sulphide of zinc. Precipitated from this solution by sulphide of ammonium (after neutralisation) it forms a dark green precipitate, which on gradual oxidation becomes white, and gives the reactions of zinc and iron.

(7.) The original white pigment allowed to remain for two days and nights in a large excess of acetic acid (which dissolves out the oxide of zinc, &c.), and the residue being well washed on a filter, this residue, when exposed to sunlight, also darkens; so that acetic acid does not, previous to the action of light, dissolve the substance which is affected by this action (and this points to *sulphide of zinc* itself as being the substance affected).

The constant presence of minute quantities of iron in the numerous samples of these white pigments which I have examined led me to believe that the dark slate-coloured product obtained by exposure to sunlight was owing to the production of a sulphide of iron, or to some compound sulphide of iron, zinc, and barium, as mentioned in my first note. In order to decide this point if possible, I took a specimen of the pigment which contained very little iron, and by exposing it over and over again to the alternate action of sunlight (reduction) and darkness (oxidation)—renewing the surface after each experiment—I hoped to oxidise the iron completely, so that a moment would arrive when the pigment would no longer darken on exposure to the light. But although this experiment was continued on a very thin layer of substance for more than a week, the newly exposed surfaces continued to darken as at first. It appears probable, then, that the minute quantities of iron present are *not* the cause of the phenomenon.

Now, as to the question of the presence of a new metallic element (Actinium) in this white pigment, let us see how far the observations already made authorise the assumption of its existence. The pigment consists of *sulphide of zinc* containing more or less oxide of zinc, together with traces or minute quantities of several impurities (iron, manganese, lead, barium—soluble in acids—calcium, sodium, arsenic, and indium), and mechanically mixed with a large amount of sulphate of baryta. We know that the mineral sulphide, *Blende*, is sometimes more or less fawn-coloured, and sometimes quite black ("Black Jack" of the Cornish miners), although it gives a whitish powder; in fact, that it is found with all the gradients of colour through which my specimens of pigment pass under the influence of sunlight. Hence, whatever causes the production of colour in this actinic phenomenon is very probably present in the natural mineral. We are also aware that Berzelius and some other chemists admit the existence of a *suboxide of zinc* of a dark grey colour, and it is possible that the suboxide, or a corresponding subsulphide, may be produced by the action of light on this mixture of substances. Again, there have been discovered of late years in zinc ores, besides cadmium and manganese, two new metallic elements, *indium* and *gallium*, the actinic properties of whose compounds have not hitherto been examined. Finally, it is by no means impossible that a new metallic element, Actinium, may be present in the specimens of white zinc examined by me, and account for the singular actinic phenomenon.

These few considerations will give some idea of the difficulties which surround the subject. The problem cannot be solved without the aid of a much larger number of observations than I have hitherto been able to make.

PS.—I have perused two short notes recently communicated to this journal by Mr. Orr and Mr. Crawley upon the subject of my first communication, but these gentlemen do not appear to have the slightest idea of the cause of the phenomenon under consideration.

Influence of Alcohol upon the Transformation of the Albumenoids.—J. Munk.—Small doses of alcohol decrease the decomposition of the albumenoids in the organism, but large stupefying quantities have the opposite effect.—*Chem. Zeitung*, iv., 20.

INDIGO, AND ITS ARTIFICIAL PRODUCTION.*

By H. E. ROSCOE, LL.D., F.R.S., &c.
President of the Chemical Society.

(Concluded from p. 69.)

THE following are the directions issued by the patentees to calico printers for using the new colour :—

PRINTING WITH ARTIFICIAL INDIGO.

No. I.—*On Unprepared Cloth.*

Standard.—Take 4 lbs. propiolic acid paste (equal to 1 lb. dry acid), and 1 lb. borax finely powdered; mix well. The mixture first becomes fluid and at last turns stiff. Then add 3 quarts white starch thickening (wheat starch), mix well, and strain.

Printing Colour.—Take the above standard and dissolve in it immediately before printing 1½ lbs. xanthate of soda, stir well, and ready for use.

For lighter shades reduce the above printing colour with the following :—In 1 gallon white starch paste dissolve 1 lb. xanthate of soda.

Directions for Use.—Print and dry as usual. The pieces ought not to be placed in immediate contact with drying cylinders, or otherwise be subjected to heat above 100° C. The indigo-blue is best developed by allowing the printed goods to remain in a dry atmosphere and at an ordinary temperature for about forty-eight hours. Damp air ought to be excluded as much as possible until the colour is fully developed. Then the pieces may be passed through the ageing machine, or steamed at low pressure if such treatment should be required for fixing any other colour or mordant printed along with the indigo-blue.

After the blue is ready formed, the pieces are first thoroughly washed in the washing machine and *then boiled* in the clean water, or better, in a weak solution of hyposulphite of soda (1 lb. to 10 gallons), *and at a full boil* for half an hour in order to volatilise the smell which would otherwise adhere to the goods.

Clean in a soap-bath, at a temperature not above 40° C.; wash, dry, and finish.

Observations.—Wheat starch gives the best results in the colour, then follows gum tragacanth. The colour is considerably reduced by using gum senegal, dark British gum, or calcined farina as thickening materials.

So far borax has answed best as an alkaline solvent of propiolic acid; it may, however, be replaced in the above standard by acetate of soda (from 1 to 1½ lbs.) or by 6 ozs. pearlash or soda. Any excess of caustic potash, or soda, destroys propiolic acid.

The above standard keeps unchanged for any length of time; it is likewise not sensibly altered by a small amount of xanthate of soda; but when mixed with its full proportion of xanthate, as in the above printing colour, it gradually loses strength after several hours.

The xanthate ought, therefore, to be mixed with the standard immediately before printing, and any colour remaining unused may then be saved by mixing with the same a large proportion of starch paste.

Propiolic acid may be printed along with aniline-black, catechu brown and drabs, and with alumina and iron mordants for madder colours.

After the indigo-blue is fully developed, the mordants are fixed in the ordinary manner, dyed with alizarin, padded with Turkey-red oil, steamed, and otherwise treated as usual.

Indigo-blue, whether natural or artificial, suffers by prolonged steaming at high pressure. For this reason, only such steam colours can be associated with propiolic acid as may be fixed by short steaming at low pressure.

No. II.—*On Prepared Cloth (for Full Shades).*

Dissolve 2 lbs. of xanthate of soda in 1 gallon of cold water. Pad the goods with the above; dry, print with standard, and after printing follow the above treatment. The pieces may also be first printed with xanthate and then covered with standard. Alumina and iron mordants for madder colours may be likewise printed on cloth thus prepared, or printed with xanthate of soda.

The potential importance, from a purely commercial point of view, of the manufacture, may be judged of by reference to the following statistics, showing that the annual value of the world's growth of indigo is no less than four millions sterling.

Estimated Yearly Average of the Production of Indigo in the World, taken from a Total Crop for a Period of Ten Years

	Pounds Weight.	Pounds Sterling.
Bengal, Tirhoot, Benares, and N.-W. India—	8,000,000	2,000,000
Madras and Kurpah	2,200,000	400,000
Manilla, Java, Bombay, &c..	—	500,000
Central America	2,250,000	600,000
China and elsewhere, consumed in the country—	—	Say 500,000
		4,000,000

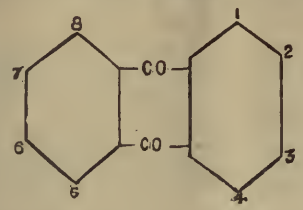
How far the artificial will drive out the natural colouring-matter from the market cannot, as has been said, be foreseen. It is interesting, as the only instance of the kind on record, to cast a glance at the history of the production of the first of the artificial vegetable colouring-matters, alizarin. In this case the increase in the quantity produced since its discovery in 1869 has been enormous; such indeed that the artificial colour has now entirely superseded the natural one, to the almost complete annihilation of the growth of madder root. It appears that whilst for the ten years immediately preceding 1869 the average value of the annual imports of madder-root was over one million sterling, the imports of the same material during last year (1880) amounted only to £24,000. The whole difference being made up by the introduction artificial alizarin. In 1868, no less a quantity than 60,000 tons of madder-root were sent into the market, this containing 600,000 kilos. of pure natural alizarin. But in ten years later a quantity of artificial alizarin, more than equal to the above amount, was sent out from the various chemical factories. So that in ten years the artificial production had overtaken the natural growth, and the 300,000 or 400,000 acres of land which had hitherto been used for the growth of madder, can henceforward be better employed in growing corn or other articles of food. According to returns, for which the speaker had to thank Mr. Perkin, the estimated growth of madder in the world previous to 1869 was 90,000 tons, of the average value of £45 per ton, representing a total of £4,050,000.

Last year (1880) the estimated production of the artificial colouring-matter was 14,000 tons, but this contains only 10 per cent of pure alizarin. Reckoning 1 ton of the artificial colouring-matter as equal to 9 tons of madder, the whole artificial product is equivalent to 126,000 tons of madder. The present value of these 14,000 tons of alizarin paste, at £122 per ton, is £1,568,000. That of 126,000 tons of madder at £45 is £5,670,000, or a saving is effected by the use of alizarin of considerably over four millions sterling. In other words, we get our alizarin dyeing done now for less than one-third of the price which we had to pay to have it done with madder.

Our knowledge concerning the chemistry of alizarin has also proportionately increased since the above date. For whilst at that time only one distinct body having the above composition was known, we are now acquainted with no less than nine out of the ten dioxy-anthraquinones whose existence is theoretically possible, according as the

* A Lecture delivered before the Royal Institution of Great Britain, Friday, May 27, 1881.

positions of the two semi-molecules of hydroxyl are changed.



Of the nine known dioxy-anthraquincnes, only one, viz., alizarin, or that in which the hydroxyls are contained in the position 1, 2, is actually used as a colouring agent. Then, again, three trioxy-anthraquinones, $C_4H_5O_2(OH)_3$, are known. One of these is contained in madder-root, and has long been known as purpurin. The other trioxy-anthraquinones can be artificially prepared. One, termed anthra-purpurin, is an important colouring-matter, especially valuable to Turkey-red dyers, as giving a full or fiery red. The other, called flavo-purpurin, gives an orange dye with alumina mordants. All these various colouring-matters can now be artificially produced, and by mixing these in varying proportions a far greater variety of tints can be obtained than was possible with madder alone, and thus the power of diversifying the colour at will is placed in the hands of the dyer and calico printer.

It is quite possible that in an analogous way a variety of shades of blue may be ultimately obtained from substituted indigos, and thus our catalogue of coal-tar colours may be still further increased.

To Englishmen it is a somewhat mortifying reflection, that whilst the raw materials from which all these coal-tar colours are made are produced in our country, the finished and valuable colours are nearly all manufactured in Germany. The crude and inexpensive materials are, therefore, exported by us abroad, to be converted into colours having many hundred times the value, and these expensive colours have again to be bought by English dyers and calico printers for use in our staple industries. The total annual value of manufactured coal-tar colours amounts to about three and a half millions; and as England herself, though furnishing all the raw material, makes only a small fraction of this quantity, but uses a large fraction, it is clear that she loses the profit on the manufacture. The causes of this fact, which we must acknowledge, viz., that Germany has driven England out of the field in this important branch of chemical manufacture, are probably various. In the first place, there is no doubt that much of the German success is due to the long-continued attention which their numerous Universities have paid to the cultivation of organic chemistry as a pure science. For this is carried out with a degree of completeness, and to an extent to which we in England are as yet strangers. Secondly, much again is to be attributed to the far more general recognition amongst German than amongst English men of business of the value, from a merely mercantile point of view, of high scientific training. In proof of this it may be mentioned, that each of two of the largest German colour works employs no less a number than from twenty-five to thirty highly educated scientific chemists, at salaries varying from £250 to £500 or £600 per annum. A third cause which doubtless exerts a great influence in this matter is the English law of patents. This, in the special case of colouring-matters at least, offers no protection to English patentees against foreign infringement, for when these colours are once on the goods they cannot be identified. Foreign infringers can thus lower the price so that only the patentee, if skilful, can compete against them, and no English licencees of the patent can exist. This may to some extent account for the reluctance which English capitalists feel in embarking in the manufacture of artificial colouring-matters. That England possesses both in the scientific and in the practical direction ability equal to the occasion none can doubt. But be that as it may, the whole honour of the discovery of artificial indigo belongs to Germany and to the distinguished chemist, Professor Adolf Baeyer, whilst towards the solution of the difficult problem of its economic manufacture the first successful steps have been taken by Dr. Caro and the Baden Aniline and Soda Works, of Mannheim.

NOTE ON PHOTOGRAPHS OF THE SPECTRUM OF THE COMET OF JUNE, 1881.*

By Professor HENRY DRAPER, M.D.

The appearance of a large comet has afforded an opportunity of adding to our knowledge of these bodies by applying to it a new means of research. Owing to the recent progress in photography it was to be hoped that photographs of the comet, and even of its spectrum, might be obtained and peculiarities invisible to the eye detected. For such experiments my observatory was prepared, because for many years its resources have been directed to the more delicate branches of celestial photography and spectroscopy, such as photography of stellar spectra and of the nebulæ. More than a hundred photographs of spectra of stars have been taken, and in the nebula of Orion details equal in faintness to stars of the 14·7 magnitude have been photographed.

It was obvious that, if the comet could be photographed by less than an hour's exposure, there would be a chance of obtaining a photograph of the spectrum of the coma, especially as it was probable that its ultra-violet region consisted of but few lines. In examining my photographs of the spectrum of the voltaic arc, a strong band or group of lines was found above H, and on the hypothesis that the incandescent vapour of a carbon compound exists in comets, this band might be photographed in their spectrum.

Accordingly, at the first attempt, a photograph of the nucleus and part of the envelopes was obtained in seventeen minutes, on the the night of June 24, through breaks in the clouds. On succeeding occasions, when an exposure of 162 minutes was given, the tail impressed itself to an extent of nearly ten degrees in length.

I next tried, by interposing a direct-vision prism between the sensitive plate and the object glass, to secure a photograph which would show the continuous spectrum of the nucleus and the banded spectrum of the coma. After an exposure of 83 minutes a strong picture of the spectrum of the nucleus, coma, and part of the tail was obtained; but the banded spectrum was overpowered by the continuous spectrum.

I then applied the two-prism spectroscope used for stellar spectrum photography, anticipating that, although the diminution of light would be serious after passing through the slit, two prisms, and two object glasses, yet the advantage of being able to have a juxtaposed comparison spectrum would make the attempt desirable; and, moreover, the continuous spectrum being more weakened than the banded by the increased dispersion, the latter would become more distinct.

Three photographs of the comet's spectrum have been taken with this arrangement, with exposures of 180 minutes, 196 minutes, and 228 minutes, and with a comparison spectrum on each. The continuous spectrum of the nucleus was plainly seen while the photography was in progress. It will take some time to reduce and discuss these photographs, and prepare the auxiliary photographs which will be necessary for their interpretation. For the present it suffices to say that the most striking feature is a heavy band above H, which is divisible into lines, and, in addition, two faint bands—one between G and *h*, and another

* From the *British Journal of Photography* of August 5, 1881.

between *h* and H. I was very careful to stop the exposures before dawn, fearing that the spectrum of daylight might become superposed on the cometary spectrum.

It would seem that these photographs strengthen the hypothesis of the presence of carbon in comets; but a series of comparisons will be necessary, and it is not improbable that a part of the spectrum may be due to other elements.

RESISTS FOR ANILINE-BLACK.

The *Compagnie Generale des Cyanures et Produits* give the following instructions concerning the use of ammonium and potassium sulpho-cyanides in calico-printing. Gum-water to which 50 grms. per litre of either of the above salts has been added completely resists aniline-black. Reds, greens, blues, violets, and catechu colours can be obtained in the same manner on aniline-black. The aniline colours, whether applied with albumen, tannin, or arsenic, are mixed with 50 to 60 grms. per litre of either of the sulpho-cyanides. These colours resist aniline-black perfectly: the colour is left pure and well-defined on a black ground. For acid colours sulphocyanide of lead should be used. Sulphocyanide of ammonium may be used successfully for alizarin-reds instead of red liquor. They are also employed in the production of persulpho-cyanogen, sometimes used as an orange colour in printing. In photography the sulphocyanides serve for toning and fixing. They are used for fixing negatives on collodion in the proportion of 800 grms. per litre of water. They may be advantageously substituted for sodium hyposulphite, which requires prolonged washing for its removal, whilst the sulphocyanides act more rapidly, are less disposed to occasion spots, do not interfere with the inalterability of the proof, and are removed with less washing.

IMPROVEMENT IN THE PRODUCTION OF MAGNESIA.

Magnesia is becoming of great importance in the manufacture of cements, artificial stones, fireproof bricks, furnace linings, retorts, &c. Many of its industrial applications have been limited by the high price of the native magnesite as imported from Greece. Magnesium chloride has been produced in abundance at Stassfurt and elsewhere, but all attempts at its conversion into magnesia have hitherto proved unsuccessful. Finely-ground lime has been added to the liquid magnesium chloride, but even with the greatest care the result has been an almost worthless article, containing only from 60 to 70 per cent of actual magnesia, and costing £4 per ton. Another process has been to concentrate the magnesium chloride liquors, and heat till hydrochloric acid was evolved and magnesia remained behind. Here also practical difficulties were encountered. The decomposition is very tedious, the acid too weak to be saleable, and the magnesia is apt to retain compounds of chlorine which interfere with its applications. If a stronger heat is used the material loses all coherence and becomes worthless. A patent recently taken out by M. Closson, of Paris, solves the problem in the simplest manner. The crude lye of magnesium chloride is treated not with burnt lime, but with burnt dolomite. In this natural combination the chlorine of the lye combines completely with the lime of the dolomite, so that if the latter is used in a state of purity—as it is readily procurable in bulk—a magnesia of from 98 to 99½ per cent can be made on the large scale without any difficulty. The process is already in operation at Leopoldshall. The magnesia bricks there prepared resist even the flame of the oxy-hydrogen blast. If lime is present, even to the extent of 5 per cent, the bricks, &c., if moistened when hot, fly into fragments. Magnesian bricks prepared about ten years ago by Tessié du Motay from Greek magnesite, and containing about 13 per cent of lime and silica, were melted in some experiments recently made in Sheffield. The cost of magnesia as prepared by the Closson process is about 15s. per ton. There is another important feature in the patent. The crude magnesium chloride contains a certain quantity of magnesium sulphate. To remove this calcium chloride is added. The sulphate of lime as thus precipitated is used by paper makers under the name of pearl-hardening, and has been specially prepared in England for their purposes.

Closson's patents for Germany, Austria, and England have been brought up by a M. Schmidtmann, a potash manufacturer of Aschersleben. It is to be expected that as absolutely fireproof furnace linings, crucibles, &c., can now be procured the use of the oxygen blast will assume a practical form, and that the way will be opened for great improvements in metallurgy.

SEPARATION OF NICKEL AND COBALT FROM IRON.

By THOMAS MOORE.

The undernoted process, which to the best of my knowledge is quite new, will, I think, prove very serviceable to metallurgical chemists in general, but more especially so to those who, like myself, are often placed in the position to estimate, with as much accuracy as is compatible with the time at disposal, the amount of nickel or cobalt in a regulus or "stem."

This process has, with other advantages, that of giving a solution very suitable for electrolysis, and this of itself is a point practical assayers will not be slow to appreciate.

If the solution contains much free acid, this should be got rid of by evaporation, and dissolving the residue in water. To the solution so obtained a quantity of ammonic sulphate should be added, sufficient to form a double sulphate with the nickel and cobalt present. Dilute to about 150 c.c., and then add rather a large excess of oxalic acid and stir well. If a precipitate forms more ammonic sulphate must be added until a clear solution is obtained. Ammonic hydroxide is now added in considerable excess; stir, heat gently for a few minutes, and filter; wash well with water containing ammonia; or dilute to say 500 c.c., and after allowing the precipitate to settle, withdraw a given portion of the clear upper stratum of liquid, which, after a further addition of ammonic sulphate (to lessen the resistance of the solution to the electric current), is ready for electrolysis or any other method of estimating the nickel or cobalt the chemist may desire.

Taking at random the results of two experiments we have,—

	Taken.		Found.
	Fe.	Ni.	Ni.
I.	0·750 grm.	0·0753 grm.	0·0755
II.	0·250 ,,	0·1507 ,,	0·1505

plainly pointing to the fact that the separation is tolerably complete.

The Determination of Reverted Phosphoric Acid by means of Ammonium Citrate.—A. König.—The author concludes from his experiments that the proportion between the phosphate and the solution of ammonium citrate has a great influence upon the result, and that in order to obtain accordant figures an equal quantity of soluble phosphate must be allowed to act upon the usual quantity of citrate—a condition practically impossible. The value of ammonium citrate for the determination of reverted phosphoric acid is thus greatly reduced.—*Zeitschrift für Analytische Chemie*, xx., 1.

IMPROVEMENTS IN BATTERIES.

By DAVID LINDO.

M. Azapis recommends (Chemical News, vol. xlii., p. 184) the substitution of solution of chloride of sodium or sal-ammoniac for the acidulated water in contact with the zinc in Bunsen's battery, the great advantage being that the zinc does not require to be amalgamated. My experience of this modification is so much in its favour that I should never resort again to the use of dilute sulphuric acid with Bunsen's cells.

As the introduction of chlorine compounds into a Grove's battery might prove injurious, I was led to try the effect of a solution of sulphate of sodium in this battery in place of the dilute sulphuric acid. The results obtained were excellent. I employ a solution containing one part sulphate of sodium in crystals dissolved in 5 parts of water. No amalgamation of the zinc is required, and the intensity of current appears to be quite as great as when dilute sulphuric acid is employed. I have used two Grove's quarts charged in this way on several occasions for the purpose of precipitating copper when estimating it in the metallic state. Solution of sulphate of sodium answers equally well in Bunsen's cells.

Falmouth, Jamaica, July 5, 1881.

ESTIMATION OF POTASSIUM AS PLATINUM SALT.

By DAVID LINDO.

Several modifications of this method of determining potassium have been suggested by different chemists: opinion seems still divided as to which modification is the best.

The Committee appointed by the British Association to enquire into this subject gives, in an able and lengthy report* (to which I am indebted for many valuable suggestions), the results of a large number of analyses made by the processes of Fresenius, Frank, and Tatlock. The conclusions arrived at are briefly as follows:—

(1.) Potassium in the form of pure chloride can be determined with great accuracy by precipitation as chloro-platinate. If a large excess of platinum be employed and alcohol only used for washing the precipitate, the results have a tendency to exceed the truth. If a small volume of platinum solution be employed in the first instance for washing the precipitate, and the washing then completed with alcohol, the results are very accurate.

(2.) In presence of a considerable proportion of chloride of sodium, washing the precipitate with alcohol alone tends to give results in excess of the truth. If the precipitate be first treated with platinum solution the results are somewhat low, apparently owing to the solubility of the precipitate in solution of sodium chloro-platinate: the error increases with the amount of sodium, but is never very large.

(3.) If Tatlock's method be employed there is no occasion to separate any sulphates, nitrates, or magnesia; but if the amount of chloride present is insufficient for the existence of all the potassium as chloride of potassium, the deficiency must be supplied by the addition of chloride of sodium or hydrochloric acid.

The final conclusion arrived at is, that of the various methods tried Tatlock's gives in general the best results. The essential features of his process consist—

(1.) In the use of a large excess of platinum.

(2.) Diluting the solutions largely.

(3.) Digesting the precipitate for at least an hour in solution of platinic chloride, washing again slightly with more of the solution, finally washing with the smallest possible quantity of 95 per cent alcohol, and drying at 100° C.

Previous to this my experience in the determination of potassium had been very limited. I had employed the method recommended by Messrs. E. F. Teschemacher and J. Denham Smith (Chemical News, vol. xvii., p. 244), and the results obtained were concordant, but I had made no experiment with potash salts of known purity.

The present investigation was originally undertaken for the purpose of testing their method more thoroughly. During the progress of the enquiry certain modifications that occurred to me were adopted, and led to excellent results. These will be described in the proper place. The essential features of Teschemacher and Denham Smith's process consist—

(1) Dilution of solutions.

(2) Use of large excess of platinum.

(3) Obtaining the potassic salt in a crystalline scale-like condition.

(4) Evaporation on water-bath to a pasty condition—no further.

(5) Washing by decantation and avoiding breaking down of the crystalline precipitate.

They wash with methylated spirit containing about 85 per cent of the alcohols.

Gooch's ingenious method for the separation of precipitates (Chemical News, vol. xxxvii., p. 181) was adopted by me throughout this investigation for the purpose of separating and finally washing the platino-potassic chloride. This process consists in filtering under pressure through a felting of purified asbestos deposited at the bottom of a platinum crucible, the bottom being perforated with numerous small holes.

The crucibles used in my experiments are of the following dimensions:—Height, $\frac{3}{4}$ inch; diameter at top, $\frac{7}{8}$ inch; diameter at bottom, $\frac{1}{2}$ inch. They are provided with light dish-shaped covers, flanged. As these merely rest on the edges of the crucibles, there is no risk of spilling the contents of the latter in putting on or taking off the covers.

I fixed the crucible in a hole made through an india-rubber stopper, which fitted into a clear white glass bottle. One end of a glass tube, open at both ends and bent at a right angle, was fixed air-tight into another hole made through the stopper, and just entered the bottle; the other end of the tube led to the filter-pump. I made the feltings thick so as to secure perfectly brilliant filtrates. Two sizes of porcelain dishes were employed; the diameter for small estimates being $3\frac{1}{4}$ inches, and for larger $4\frac{1}{2}$ inches, the lips well formed.

The following atomic weights were employed:—

Chlorine	35·46
Potassium	39·13
Platinum	197·18
Silver	107·93

The three first give the factor 0·3050 for converting the chloro-platinate into chloride of potassium. I will describe—

(1) Preparation of platinic chloride.

(2) Preparation of pure chloride of potassium.

(3) The methods employed and results obtained.

(4) Results of a few experiments on the solubility of the chloro-platinate.

*Preparation of Platinic Chloride.**

Commercial platinum was converted into crude platinic chloride. Reduced, by boiling in solution of soda, and adding alcohol. Washed the metal thoroughly. Boiled for about an hour in HCl. Washed, dried, and ignited. Boiled a short time in nitric acid. Violent bumping. (This always occurs when the spongy metal is boiled in the acid after ignition.) Washed. Tested sample of the metal by

* Chemical News, vols. xxxv. and xxxvi.

* The process is the same as that employed by Tatlock and others. The residues were recovered in the same way.

boiling in pure nitric acid. Iron and copper present in more than slight traces. Placed all the metal in a beaker. Added pure nitric acid, S.G. 1·24. Covered with a dish, and digested twenty-six hours with frequent stirring—eighteen hours of the time on the sand-bath at a temperature near boiling-point. Tested a sample of the metal after washing. Traces of iron and copper still present. Repeated the digestion in the same way for twenty-six hours longer in fresh acid. Washed, dried, and ignited. Weighed. Dissolved in *aqua regia* (very pure acids employed). Evaporated three times with HCl, then repeatedly with water as near to dryness as possible. The final product still contained HCl, which it appears impossible to remove entirely at the temperature of the water-bath. Added water. Filtered. Weighed the small residue and deducted from weight of metal. Diluted further, so that 20 c.c. of the solution contained 1 grm. of platinum.

So far as my experience goes, this method of purification, when conducted with ordinary care, yields a product (even from a pretty impure sample of commercial platinum), which gives accurate results when tested by assays made with pure KCl. As this is sufficient proof of its fitness for the intended purpose, little more need be said on the subject. I may, however, add that according to my observation the *complete* separation of iron and copper from platinum can only be effected by this process with great labour, if indeed it can be accomplished at all, and that it must not be supposed the platinic chloride used in these experiments was *absolutely* pure, it certainly was not for all the time and trouble expended in trying to obtain it so.

*Preparation of Pure Chloride of Potassium.**

Chlorate of potash was purified by re-crystallisation, ignited until all the oxygen was expelled, dissolved in water, the solution filtered, then slightly acidulated with pure HCl. Evaporated to dryness, ignited, reduced to powder, and bottled. The salt gave a very pure potash reaction in flame. Other tests applied failed to detect any impurity whatever. 10 grms. dissolved in 90 grms. water, forming a 10 per cent solution. Four more solutions of the same strength had to be prepared in the course of this investigation; call these solutions A, B, C, D, E.

Analyses with nitrate of silver gave the following results. The solutions were weighed.

		KCl taken.	Wght of AgCl.	= KCl p.c.
A.	1	0·45815	0·8803	99·94
A.	2	0·59295	1·1395	99·96
B.	1	0·53046	1·0200	100·03
B.	2	0·56068	1·0787	100·07
B.	3	0·59016	1·1349	100·04
B.	4	0·50128	0·9638	100·02
C.	1	0·54440	1·0464	99·97
C.	2	0·51112	0·9834	100·08
C.	3	0·45332	0·8706	99·90
D.	1	0·57948	1·1135	99·96
D.	2	0·56211	1·0809	100·03
E.	1	0·49570	0·9532	100·03
E.	2	0·51534	0·9904	99·97

The five solutions employed have therefore given the following average results by analyses with nitrate of silver:—

A.	Mean of two experiments	99·95 p.c. KCl
B.	Average of four experiments	100·04 ,,
C.	Average of three experiments ..	99·98 ,,
D.	Mean of two experiments	99·99 ,,
E.	Mean of two experiments	100·00 ,,

* The method was suggested, and afterwards employed, by the Committee.

I have placed the letter indicating the solution used against each of the experiments given in the tables that follow.

(To be continued.)

ON SALT-BUSH AND NATIVE FODDER PLANTS OF NEW SOUTH WALES.*

By W. A. DIXON, F.I.C., F.C.S., Technical College, Sydney.

In all civilised countries much attention has been directed to the composition and value of the various fodder plants grown in them, ever since Leibig first directed attention to the valuable aid which agriculture might obtain from the study of such subjects by chemical methods. That this should be so is not susprising, seeing the important *rôle* which the cultivation of these plants plays in European agriculture, forming, indeed, the foundation on which modern farming is based, feeding the animals which not only supply meat and much of our clothing, but also furnish the greater part of the manure required to bring the vegetable food of man to perfection. It is, however, somewhat surprising that in this country no attention whatever has, as far as I can learn, been directed to the native plants, and the more so when perhaps three-fourths of the wealth of the community is, or has been, derived from its flocks and herds. For many reasons foreign to the purpose of this paper, it has been too much the interest of every one to let the sheep and cattle of to-day eat the best there is, even if they destroy it off the face of the earth, without regard to what those of to-morrow will do. It seems reasonable to suppose that in our peculiar climate, subject to periods of continued drought, and having in many cases soils peculiarly saline, that the plants which have withstood these influences for ages past would be more reliable than others developed under indifferent conditions of soil and climate. That many introduced plants do flourish here and grow with a vigour never seen in their native habitats is undoubted, but, as Dr. Schomberg remarks in his pamphlet on introduced weeds in South Australia, it remains to be seen whether that increased growth may not be the means of their own destruction.

It has therefore been thought of sufficient interest to induce me to make a beginning, by examining a few of those plants which form the staple pasture of the famed Riverina district, and I now lay the results before you, accompanying them with a table showing the average composition of other fodders of good quality for comparison. All the European plants which are used for feeding vary greatly in composition at different periods of their growth, and I have selected analyses of hay or straw made of the plant at the period of flowering, when they are at their best. The analyses have all been re-calculated from the authorities given, so as to reduce them to the same method of statement adopted for my own work. The analyses of the meadow hay, red clover, and lucerne were all stated as containing 15 per cent of water, which is the average in well made hay; and the ashes were all, with the exception of the oats, given in 100 parts of ash only, and that containing carbonic acid, and the chlorine was given in the free state. As the plants which are to be brought under your notice are not used in the form of hay, and as the specimens examined had in their long journey become in some cases partially dried, and in others (the more succulent ones) were in a state of incipient fermentation, which rendered it necessary to dry them as rapidly as possible, no water determinations were made, and the analyses are given on the dried plants.

Immediately on their arrival they were divided into woody portions, and tender parts, including small twigs and every part it was considered probable that the sheep

* A Paper read before the Royal Society of New South Wales.

would eat; the separate parts were weighed, and a sufficient quantity of the edible matter was dried on a water-bath, and afterwards ground in a coffee mill for the proximate organic analyses. The remainder of the plant was partially air-dried and then charred in a clay crucible at a dull red heat; from the excessive quantity of alkaline salts present it was found impossible to remove much more of the carbon without running serious risk of losing part of the salts by volatilisation, and the analyses were therefore made on the charred material, which generally contained about 50 per cent of carbon. In determining the quantity of ash the carbon was removed as far as possible by incineration, the remainder being afterwards determined and deducted. As the char evolved sulphuretted hydrogen on treatment with acid, it was moistened with concentrated nitric acid for the estimation of sulphuric and phosphoric oxides. In calculating the analyses the carbon dioxide, sand, and alumina found have been deducted, following in respect to the first the Continental method. It is not, properly speaking, an inorganic constituent, the salts not being in combination with it in the plant; and although its rejection is regarded by some English chemists as removing a distinctive feature of the ash, that is simply a question of what one regards as such feature. In some of the ashes—that from plants which could be well dusted—there was no sand nor alumina, and in the others the amount of these constituents rose and fell together, showing that both were derived from adherent impurity; but as no such connection could be observed with regard to the soluble silica, this has been retained. A large portion of each ash was examined for manganese and the rarer constituents of plant ashes, which could in no case be detected. The greatest variation in the original ash analyses amounted to 0·24 over and 0·31 under 100, and I have therefore, for simplicity of calculation, ventured to calculate the analyses into 100 parts exactly. The ash analyses are stated in two columns, the first showing the composition in 100 parts, the second on the dried plant.

No. 1. *Atriplex sp.* Dwarf salt-bush.

Oil	2·94
Carbohydrates	40·96
Albumenoids	14·68
Woody fibre	15·60
Ash—CO_2	25·82
	100·00
Nitrogen	2·35
Woody parts of plant	37 per cent.
Edible „ „	63 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	21·18	5·47
Soda	49·34	12 74
Chloride of sodium	2·31	0·60
Lime	12·74	3·29
Magnesia	4·83	1·25
Ferric oxide	0·73	0·19
Sulphuric oxide	4·43	1·14
Phosphoric „	2·80	0·72
Silica soluble	1·64	0·42
	100·00	25·82

No. 2. *Atriplex campanulata.* Small salt-bush.

Oil	2·24
Carbohydrates	43·47
Albumenoids	12·25
Woody fibre	18·12
Ash—CO_2	23·92
	100·00
Nitrogen	1·96
Woody parts of plant	8 per cent.
Edible „ „	92 per cent

Ash Analysis.	On Ash.	On Plant.
Potash	13·61	3·25
Soda	26·22	6·27
Chloride of sodium	35·36	8·46
Lime	8·47	2·03
Magnesia	5·82	1·39
Ferric oxide	1·83	0·44
Sulphuric oxide	2·62	0·63
Phosphoric „	3·80	0·91
Silica soluble	2·27	0·54
	100·00	23·92

No. 3. *Atriplex sp.* Salt bush weed.

Oil	2·08
Carbohydrates	43·19
Albumenoids	13·37
Woody fibre	14·88
Ash—CO_2	26·48
	100·00
Nitrogen	2·14
Woody parts of plant	4 per cent.
Edible „ „	96 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	20·21	5·25
Soda	40·82	10·81
Chloride of sodium	7·95	2·10
Lime	14·56	3·96
Magnesia	5·13	1·36
Ferric oxide	0·92	0·24
Sulphuric oxide	2·57	0·68
Phosphoric „	4·41	1·17
Silica soluble	3·43	0·91
	100·00	26·48

No. 4. *Atriplex sp.*

Oil	2·28
Carbohydrates	43·64
Albumenoids	12·68
Woody fibre	14 44
Ash—CO_2	26·96
	100·00
Nitrogen	2·19
Woody parts of plant	46 per cent.
Edible „ „	54 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	29·38	7·92
Soda	23·56	6·35
Chloride of sodium	12·46	3·36
Lime	15·47	4·17
Magnesia	6·96	1·88
Ferric oxide	1·21	0·33
Sulphuric oxide	1·01	0·27
Phosphoric „	3·44	0·93
Silica soluble	6·51	1·75
	100·00	26·96

(To be continued.)

Determination of the Melting-Point of Fats.—O. Kellner.—The author uses a straight capillary tube with a club-shaped expansion at one end. The latter is closed and before it is quite cold the capillary end is plunged into the liquid fat. A stratum 3 to 5 c.m. in length is allowed to enter, and this end of the tube is quickly plunged into cold water, the club-shaped end remaining above the surface. If the tube is then plunged into warm water, and heat applied at the moment of melting, the fat rises into the vacuum, the exact point of temperature being easily noticed.—*Zeitschrift für Anal. Chemie*, xx., 1.

CORRESPONDENCE.

ANALYSIS OF GERMAN MURIATE OF POTASH.

To the Editor of the Chemical News.

Sir,—I am sorry to see so much personal feeling introduced into the discussion of a purely chemical controversy as appears in Messrs. E. F. Teschemacher and J. Denham Smith's correspondence in the Chemical News, vol. xliv., p. 35.

My firm (John and James White) are large buyers and consumers of German muriate of potash, and having made many hundred analyses of them by all the known methods, I think I can speak with some little experience.

I value Tatlock's method highly, and have proved the advantage of using the "aqueous solution of platinic chloride," not only in commercial muriates with their 1·5 per cent "soda salts," but also in other mixtures which I have frequently to analyse, and which contain, along with metallic salts, potassium sulphate, potassium chloride, with upwards of 40 per cent sodium sulphate.

I am surprised to see Messrs. Zuckschwerdt and West, as representing the German muriate manufacturers, criticising Mr. Tatlock's method in the way they do; pointing out items, which are quite secondary, as reasons for condemning his process, while their own process condemns itself at the outset by making use of alcohol before having got rid of the sulphates of the alkalies and alkaline earths.

Though Prof. Fresenius gives credit to their paper, it is quite contrary to his own use and wont, and to all laws of chemical analyses.

There is no practical value in making 40 or even 400 analyses of a made up muriate containing only potassium chloride and sodium chloride in order to test Fresenius's, Tatlock's, Zuchschwerdt and West's, Teschemacher and Smith's, or anybody else's method. Anyone, with ordinary care, could determine the potash in such a salt by any of these methods to within 0·35 per cent; but German muriate does not consist of pure KCl and pure NaCl, but of potassium chloride, potassium sulphate, calcium sulphate, sodium chloride, magnesium chloride, insoluble matter, and water. Most of these salt which are not in the made up salt are the very items which in most methods are the source of error.

Tatlock's method is a rapid and accurate one for estimating potash *direct* from this mixture of salts, washing out the soda, lime, and magnesia salts, and leaving the double platinum salt pure; the average of many analyses coming out 99·99 per cent. The German method, which adds alcohol to the basin after evaporation (see Zuckschwerdt and West's paper, Chemical News, vol. xliii., p. 252), precipitates the sulphate of lime, &c., along with the potash, with which it is then weighed; and if the analysis is checked by separation of the salts and repetition, there will be found a difference of from 1 to 2 per cent.

Messrs. Zuchschwerdt and West in their paper say "that the first drops of Tatlock's filtrate are rendered turbid by the addition of absolute alcohol." This is quite true, and is just what is wanted, but the precipitate is not potassium platino-chloride, as they state, but crystallised calcium sulphate. They, of course, do not get this turbidity, as it is caught on their filter along with their platinum precipitate.

Messrs. Teschemacher and Smith at the close of their letter say, "As respects German makers and English buyers of muriate of potash, we take leave to say that if these gentlemen can transact their business, selling and buying within a quater per cent of the actual value, they will be contented."

My firm would certainly be contented even with one-half per cent. The facts, however, are very different, for the difference in all cases amounts to 1 or 2 per cent.

German analyses come over to this country showing potassium chloride and water, together making up the 100 per cent, and leaving no room for the sulphates of potassium and lime, the chlorides of sodium and magnesium, or insoluble matter, which everyone knows must exist. Why is this? Is it not because they precipitate the impurities along with the potash?

We buy the best muriates that are made, and find that on the average they contain besides potassium chloride and water—

	Per Cent.
Sulphate of potash	0·22
Chloride of sodium..	1·00 to 1·50 per cent.
Sulphate of lime	0·40
Chloride of magnesium.. ..	0·12
Insoluble matter	0·20
	1·94 to 2·44 per cent.

The German manufacturers might be willing to pay for common salt, gypsum, and magnesium, as if they were muriate of potash, the British consumer, however, prefers to pay only for what he gets.—I am, &c.,

W. J. Chrystal.

Shawfield Works, Rutherglen,
Near Glasgow, August 2, 1881.

ON A NEW METHOD FOR ESTIMATING NITRATES IN POTABLE WATER.

To the Editor of the Chemical News.

Sir,—Mr. Johnstone still asserts that my process is not new, but he has omitted to give a reference to any paper written on the subject previous to mine; if he can and will kindly do so, I shall be much obliged, for until he does I am unable to answer the charge.

Mr. Johnstone is quite right in saying that the standard red solution is liable to decompose, for I find it will not keep more than a week or so: the remedy is obvious. I may, perhaps, also be allowed to state in connection with my method, that the addition of a little caustic baryta is required to waters containing much sulphate before the evaporation, to prevent the occurrence of free sulphuric acid and consequent partial destruction of the red colouration.—I am, &c.,

J. West Knights.

County and Boro' Laboratory,
Cambridge, August 8, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 1, July 4, 1881.

This number merely contains the notice of the death of M. E. H. Sainte-Claire Deville, and the discourse pronounced by M. Pasteur at his funeral.

Journal de Pharmacie et de Chimie.
February, 1881.

Observations on Albuminous Urine.—M. Bretet.—The author finds that it is not necessary to eliminate albumen from urines which contain it before determining the urea.

March, 1881.

Remarks on the Characters of Organic Chlorinated Gases and Vapours.—M. Berthelot.—Already noticed.

Researches on the Physiological Action of Thio-tetra-pyridine and Iso-dipyridine.—M. Vulpian.—These bases, though derived from nicotine, do not appear to have the slightest poisonous action upon mammiferous animals.

Determination of Tannin.—A. Remont.—The author after reviewing various processes gives the following:—He places 20 grms. of the sample well ground in a tall tube-shaped vessel, to the bottom of which is adapted a caoutchouc pipe closed by a pinch-cock. The material is moistened with 60 to 80 c.c. of water at 60°, which is allowed to act till the next day. The pinch-cock is then opened, and the liquid is received in a phial having a mark at 200 c c. The bark is then taken out of the vessel, drenched afresh with 50 to 60 c.c. of luke-warm water, which is received in a glass, and which is poured back upon the sample two or three times. The exhaustion is thus continued until a portion of the liquid gives merely an insignificant colouration with a few drops of dilute ferric chloride. In general, the volume of the liquid does not exceed 200 c.c. This exhaustion must be conducted rapidly, otherwise the tannin may be decomposed. For determining the tannin the author uses a solution of gelatin, containing 1 part per cent of gelatin, which is standardised by means of a solution of pure dry tannin, also containing 1 part per cent. 10 c.c. of this latter solution are mixed with 3 drops of sulphuric acid, which greatly aids the precipitation. The solution of gelatin is then run in, stirring continually. As long as the tannin is still present in a certain quantity the precipitation goes on easily, but towards the end it is well to accelerate it by warming gently. The determination of tannin in the solution of the sample is performed on 20 c.c. acidulated with 6 drops sulphuric acid. In certain cases, in spite of the temperature and the acidity of the liquid, the tannate of gelatin is not completely deposited, and the persistent cloudiness prevents the effect of any further addition of the solution of gelatin from being observed. In this case a part of the liquid is thrown upon a small filter placed in a funnel for rapid filtration, and a drop of gelatin is added to the filtrate. If a turbidity is produced this portion is poured back to the bulk of the liquid, and the titration is continued, examining from time to time filtered portions of the liquid with gelatin.

Detection and Determination of Arsenic.—M. E. Reichardt. — This paper requires the accompanying illustrations.

April, 1881.

Action of the Hydracids upon Halogen Salts Containing the same Element.—M. Berthelot.—Already noticed.

Vanilla and Vanilline.—A. Yver.—The author gives a summary of the formations of vanilline. In a state of purity it melts at 80° to 81°, and is very soluble in boiling water, alcohol, ether, chloroform, carbon bisulphide, and the fatty and volatile oils. In cold water it is slightly soluble. It decomposes carbonates and neutralises alkaline bases in the cold, and earthy bases with the aid of heat. It is turned blue by ferric chloride, and yellow by sulphuric acid in the cold. If it contains traces of nitric acid there is a scarlet colouration.

Determination of Indigotin in the Indigos of Commerce.—A. Damoiseau.—The author prepares a liquid containing 100 grms. syrup of glucose, 500 c.c. of water, and alcohol enough to make up a litre. 1 grm. of the indigo in question, finely ground, is placed in a flask fitted with a cork, through which passes a tube drawn out to a point. There is then added a mixture prepared separately, and quite clear, of 10 c.c. soda-lye at 45° (Beaumé ?), 10 c.c. water, and 10 c.c. alcohol. The soda-lye should under these conditions occasion neither precipitate nor turbidity. After agitation, 30 c.c. of the saccharine liquid are introduced, the flask is corked and heated on the water-bath, stirring from time to time. In less than twenty minutes the reduction is complete, and the liquid has become of a fine light yellow colour. It is then requisite to filter through a plug of cotton, placed at the lower end of a tapering tube, wide enough to receive the whole of the liquid at once. The filtration is conducted with the aid of an aspirator. A current of some inert gas, *e.g.*, coal-gas, is allowed to enter at the upper end to prevent oxidation. A rather rapid current of air is then passed through the filtrate, and in two hours the whole of the indigotin is precipitated in a state easy to wash. It is placed on a filter, washed with alcohol at 40 per cent, dried at 100°, and weighed.

May, 1881.

Cause of Error in Proximate Analysis.—M. Schlagdenhauffen.—The author has found a considerable impurity of sulphate of lime in the litharge and lead acetate used in the proximate analysis of vegetable matters.

Butter and Margarine.—M. Riche.—The author finds that the difference of specific gravity between butters, on the one hand, and margarine, oleo-margarine, and a mixture of margarine and oil of earth-nuts on the other, is very limited, and that consequently no apparatus based upon specific gravity is capable of showing the relative proportion of fats and butter found in commercial mixtures.

Asphyxiating Action of Cess-pool Drainage.—MM. Boutmy and Descoust.—A cubic metre of cess-pool liquid, even after official disinfection, rendered 8 cubic metres of air fatal to animals immersed therein.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 1.

Danger-Test for Petroleum.—C. Engler and R. Haass.—The authors sum up the results of their observations and experiments as follows:—Every form of apparatus by which a conclusion is drawn from the vapour-tension of the petroleum to its inflammability, like those of Salleron-Urbain, Van der Weyde, Meusel, &c., are to be rejected, as vapour-tension bears no simple relation to inflammability. Every apparatus with an open petroleum holder gives flashing-points, either too high or not mutually concordant; hence they are useless for determinations which lay even a remote claim to accuracy. Such are the open apparatus of Tugliabue, the Danish petroleum-tester, the Saybolt-tester, the apparatus of Erneeke-Hannemann, Kyll, &c, Among the closed instruments all are to be rejected by which imperfectly accordant results are obtained, in consequence of the employment of a false principle or of small variations in manipulation unavoidable in practice. Under this head must be included both Tagliabue's closed instruments, the pyrometer of Sintenis, and the naphthometer of Parrish. Of the remaining instruments, that of Bernstein and that of Abel give comparable results, and work with certainty. The determinations of the former apparatus are always too low, and those of the latter too high, especially with oils of a low ignition-point. The apparatus of Bernstein has the advantage that the final reaction can be easily and distinctly observed, whilst in Abel's instrument the difficulty of observing faint ignitions must rank as a disadvantage. In currents of air, however, the latter apparatus will work more safely than that of Bernstein, which is more difficult to use on account of its complicated mechanism. The two closed electric instruments of Haass and Engler give the most exact results. Next follows in point of trustworthiness and accuracy the improved naphthometer.

The Applicability of the Azometer in Investigations in Agricultural Chemistry.—Dr. A. Morgen.— This method gives very satisfactory results in pure solutions of ammoniacal salts. It is entirely useless for determining the ammoniacal nitrogen in solutions which, along with ammonium compounds, contain organic nitrogenous bodies, albumenoids, amides, peptons, ferments, alkaloids, glycerides, since these substances are decomposed by a brominised soda-lye with the development of gas. If the ammoniacal salts are accompanied by non-nitrogenous

organic bodies the method is applicable, but if the proportions of such bodies are high the results are not very accurate. For the determination of the ammonia split off from amidoid compounds by the action of acids the azometer is entirely useless.

Determination of Soluble Phosphoric Acid in Superphosphates.—S. Drewsen.—The author finds it necessary to boil the solution with nitric acid before the molybdenum mixture is added.

Determination of Glycerin in Beer,—Dr. F. Klausner.—The author criticises existing processes and gives a method of his own, which cannot be described without the accompanying diagram.

Determination of Nitroglycerin in Dynamite.—W. Hempel.—This paper cannot be usefully reproduced without the accompanying illustration.

Detection of Salicylic Acid in Urine.—Dr. A. Bornträger.—The author gives the preference to the process of Robinet, who precipitates the urine with an excess of lead acetate, removes lead from the filtrate by means of dilute sulphuric acid, and tests with ferric chloride.

Determination of Arsenic as Magnesium Pyro-Arseniate.—Dr. F. Reichel.—The author places the well-dried precipitate as completely as possible in a watch-glass, moistens the filter with a solution of ammonium nitrate, dries, and burns it, previously cut up into pieces in a porcelain crucible. When the crucible is cold the contents of the watch-glass are introduced into it, a few drops of nitric acid are introduced so as to saturate the whole precipitate, and the crucible is dried at 100°, or heated carefully over a small gas-flame, to prevent spirting. As soon as watery vapours no longer escape the crucible is closed and ignited strongly for ten minutes.

Aluminium Phosphate.—Dr. L. L. de Koninck and Thiriart.—In presence of an excess of phosphoric acid or of alkaline phosphates, aluminium phosphate is easily and completely soluble in ammonia.

Determination of Tannin.—J. Löwenthal.—Dr. Seippel, of Barmen, states that in executing Löwenthal's method of determining tannin, it is advantageous, after adding the acid water to the mixed solutions of tannin and glue, to stir well for about five minutes. The liquid filters readily.

Universal Spectroscope.—C. H. Wolff.—The author has arranged an instrument equally applicable for observing the spectra of flames and absorption-spectra, and for quantitative operations.

Parke's Method for the Volumetric Determination of Copper.—R. Ulbricht.—The method yields good results if the operator proceeds in determining the value of the cyanide solution exactly as in the determination of the copper itself. There must be in each case an equal quantity of free and of combined nitric acid, an equal proportion of free ammonia, an equal quantity of one and the same ammoniacal salt, and after titration the same volume of liquid results in each case. The addition of the cyanide solution must take place always in the same manner, and within the same space of time. The proportion of copper in the liquid on determining the standard of the cyanide solution should not deviate essentially from the proportion in the liquid to be analysed. The cyanide should be standardised on the same day when the analyses are to be performed.

Spectroscopic Detection of Indium.—S. Wleügel.—On using a Bunsen burner to produce the flame-reaction quantities small as 1-3000 m.g. can be detected in a solution of the chloride in water. On examining a mixture representing a blende with 20 per cent of iron the limit of perceptibility lies between 0·001 and 0·0001 per cent.

Determination of the Halogens in Chlorates, Bromates, and Iodates.—F. Fleissner.—The substance is boiled for an hour with an excess of zinc powder, washed with boiling water,—at first by decantation. The filtrate is acidified with nitric acid, and in it the halogens are determined in the ordinary manner by precipitation with silver nitrate.

Spectroscopic Determination of Nitric and Phosphoric Acids.—H. Settegast.—This paper does not admit of useful abstraction.

Ergotinine.—C. Tanret.—An extensive paper, not suitable for abridgment.

Solubility of Cane-Sugar in Water.—H. Courtonne.—A solution of sugar saturated at 12·5° contains 66·5 per cent of sugar, and one saturated at 45° contains 71 per cent.

Determination of the Organic Impurities of Drinking-Water.—G. Lechartier.—A modification of the well-known Frankland-Armstrong process. The author determines carbon and nitrogen separately. In case of the latter he destroys the carbonates and nitrates of the water, not by means of sulphurous acid but by evaporating 1 litre water with about 0·2 grm. calcined magnesia.

Milk-Analysis.—A. Müller.—A full account of the author's process which cannot be reproduced without the accompanying illustration.

Presence of the Seed of Agrostemma Githago in Flour.—A. Petermann.—This impurity is best discovered microscopically.

Tests for Lubricating Oils and Determination of their Proportion of Acid.—E. Laugier.—Inserted in full.

Determination of Yeast.—M. Hayduck.—The author counts the number of cells observed in a given space with the microscope.

Determination of Albumenoids and Non-Albuminous Nitrogen Compounds in Cattle Food.—A collection of methods proposed by various authors.

Determination of the Cinchona Alkaloids.—A review of processes, not capable of useful abstraction.

Examination of the Salts of Quinine.—This paper does not admit of abstraction.

Examination of the Ethereal Oil of Bitter Almonds.—M. Boyveau.—The spurious oil has the sp. gr. 1·029 to 1·030, whilst that of the genuine is 1·043, or according to other statements 1·045 to 1·060. The genuine oil if mixed with an equal volume of sulphuric acid turns red, but remains limpid and clear. The spurious oil turns dark-red, and then becomes brown, dull, and thick, and congeals to a brownish mass.

The following processses relate to physiology and pathology:—

"Detection of Carbonic Oxide Hæmoglobine."—Th. Weyl and B. v. Anrep.

"Quantitative Determination of Sulphuric Acid in Urine."—E. Salkowski.

"Influence of the Presence of Grape Sugar on the Determination of Urea by means of Sodium Hypobromite."—MM. Jay and Mehu.

"Bunsen's Method of Determining Urea."—M. Hoppe-Seyler.

"Determination of Urea by Liebig's Process."—E. Salkowski.

"Determination of Nitrogen in Urine on the Principle of Dumas."—E. Ludwig.

"Determination of Nitrogen in Urea on the Will-Varrentrapp Process."—M. Flavart.

"A New Reaction of Guanine."—St. Capranica.

"Detection of Peptone in Urine."—F. Hofmeister.

Justus Liebig's Annalen der Chemie,
Band 207, Heft 1.

Atomic Weight of Platinum.—Dr. K. Seubert.—In the eighth family of elements (according to the classification of Lothar Meyer and Mendelejeff) and in the third group including osmium, iridium, and platinum, which form a transition to gold in the B group of the first family,

there were till lately a series of irregularities. Instead of the successive order, Os<Ir<Pt<Au, which theory demands, the accepted atomic weights of the elements led to the arrangement Au<Pt=Ir<Os. Two years ago the author, at the request of Prof. L. Meyer, undertook a revision of the atomic weight of iridium, which he found = 192·644; consequently Ir<Pt. He now communicates the results of his investigation on the atomic weight of platinum, which he finds = 194·177. Its position, Ir<Pt<Au, is consequently in accordance with its properties in so far as they can be regarded as a function of the atomic weight. There is still an anomaly in the position of osmium with its atomic weight, 198·5, beyond gold, though it should probably be about 192, and stand before iridium.

Communications from the Laboratory of the Victoria University at Manchester.

1. The Vanadium Sulphides.—W. E. Kay, Dalton Chemical Scholar, Owen's College.—The precipitates obtained by Berzelius were oxygenous compounds. The preparation which he produced in the dry way was a true vanadium sulphide, V_2S_4. Besides this tri-sulphide there exist a di- and a penta-sulphide. The vanadium sulphides are less permanent than the corresponding oxides.

2. Pentathionic Acid.—Toyokichi Takamatsu and Watson Smith.—The authors demonstrate the existence of pentathionic acid, and expect to be able to produce well-crystallised pentathionates.

Isomeric Xylidines.—E. Wroblewsky.—Coal-tar contains three xylols, from each of which a xylidine can be obtained. The author has produced the xylidine corresponding to ortho-xylol.

Azo-Derivatives of Toluol.—J. Barsilowsky.—Not suitable for abstraction.

Note to the Memoir "On Gay-Lussac's Hypochloro-nitric Acid."—Dr. H. Goldschmidt.—The author mentions that Prof. Tilden had previously rendered the non-existence of the compound $NOCl_2$ very probable, though not absolutely certain.

Band 207, Heft 2.

Constitution of the Sulph-hydantoins and Sulphurethans.—C. Liebermann.—An extensive memoir, incapable of useful abstraction.

Causes of the Flame of the Bunsen Burner becoming Luminous, in Consequence of the Heating of the Burner-tube.—R. Blochmann.—A discussion of the views on this subject previously put forward by Wibel and Heumann.

Compounds of the Elements of the Nitrogen Group with the Radicles of the Aromatic Series.—A. Michaelis. —Fourth Memoir: Constitution of Phosphonium and Arsenium Compounds.—The compounds here examined are the derivatives of diphenyl-arsen-chloride and of diphenyl-phosphor-chloride. The author's researches show that both in the phosphorus and the arsenic series, so long as the same number of the same organic radicles are present, the properties of the phosphonium or arsenium compounds are independent of the relative position of these radicles. Hence it is highly probable that in these compounds the elements of the nitrogen group are penta-valent.

Behaviour of Cinchomeronic Acid when Melted.—S. Hoogewerff and W. A. van Dorp.—On melting cinchomeronic acid and also tri-carbo-pyridic acid there is formed a mixture of two mono-carbo-pyridic acids, namely, γ-carbo-pyridic acid and nicotic acid.

Para-cholesterin from Æthalium Septicum.—J. Reinke and H. Rodewald.—The authors have succeeded in isolating the compound in question from the protoplasm of *Æthalium septicum*. In its general properties the substance agrees with the cholesterin and iso-cholesterin of the animal body, and with the cholesterin discovered by Beneke in the pea.

Ortho-anisidin and Amido-dimethyl-hydroquinon.—Otto Muehlhaeuser.—The author examines ortho-nitro-anisol, ortho-anisidin with its hydrochlorate, hydrobromate, hydriodate, nitrate, sulphates, oxalate, and picrate; aceto-aniside with its nitro- and dinitro- derivatives, benzoyl-aniside, the anisyl-ureas and sulphureas, mono- and di-methyl-anisidin, metoxyquinon, nitro-dimethyl-hydroquinon, and amido-dimethyl-hydroquinon.

Band 207, Heft 3.

Optical Rotatory Power of Malic Acid and of its Salts.—Dr. G. H. Schneider.—If we gradually proceed from dilute aqueous solutions of free malic acid, which are lævo-rotatory to more concentrated solutions, the specific rotation first gradually decreases, and when the percentage of the acid reaches 34 it disappears entirely, and on further concentration it passes over into a deviation to the right. The behaviour of the majority of the malates is analogous. The effects of the presence of optically inactive acids were also examined. In presence of sulphuric acid the reversal of the direction of rotation takes place even in very dilute solutions. Sulphuric acid, therefore, has an action opposite to that of water. The action of acetic acid is similar to that of sulphuric acid, but much feebler. The so-called law of multiple rotatory proportions, proposed by Krecke and maintained by Thomsen, does not hold good in the case of malic acid and its salts.

Studies on Quinamine.—O. Hesse.—The author's experiments show that quinamine bears no relation to the ordinary cinchona alkaloids, such as quinine, cinchonine, and their isomers, and has nothing in common with them beyond its occurrence in certain cinchona barks.

New Platinum Salts.—O. Hesse.—The author has obtained neutral platinum salts of the cinchona alkaloids by the following process:—Aqueous solutions of the neutral hydrochlorates of quinine, cinchonine, conchinine, cinchonidine, and homo-cinchonidine, slightly heated, are mixed with sodium platino-chloride, when the desired salts are precipitated, and are almost insoluble in cold water.

Researches from the Chemical Institute of the University of Strassburg.—These investigations consist of a memoir on the diphenyl bases, by G. Schultz; a paper by H. Schmidt and G. Schultz, on benzidine (*a*-diamido-phenyl); an account of diphenyline (*β*-diamido-phenyl), by G. Schultz, H. Schmidt, and H. Strasser; and a memoir on the constitution of the diphenyl derivatives, by G. Schultz.

Le Génie Civil. No. 11, April 1, 1881.

Taxation of Alcohols with Reference to the Manufacture of the Alkaloids in France.—The writer points out the difficulty in which French manufacturers of alkaloids are placed in consequence of the taxation of alcohol.

KING'S COLLEGE, LONDON.—MEDICAL DEPARTMENT.

The WINTER SESSION will be opened on Monday, October 3rd, at Four p.m., when the Distribution of Prizes will take place, and an address be given by Sir JOHN LUBBOCK, Bart., M.P., F.R.S., D.C.L.

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THE CHEMICAL NEWS.

VOL. XLIV. No. 1134.

PREPARATION OF PURE NAPHTHALEN.

By WILLIAM W. STAVELEY.

PROF. LUNGE, in his recent communication on the above (CHEMICAL NEWS, vol. xliv, p. 65), in assuming that "the manufacture of pure naphthalen on a large scale and at a cheap rate is still considered a secret process, and is not known to many tar distillers," is, unwittingly, unjust to tar distillers generally. And I would here remark that many writers on coal-tar products, unconnected with the trade, take it for granted that the processes in the tar works are now carried on in the same happy-go-lucky style as they were thirty years ago, when tar was to be got for the asking. In no branch of chemical industry is the competition more keen or the necessity greater for economical improvements, and tar distillers are on the alert to investigate every improvement which chemical science has to offer them. I think I may safely assert that in all large tar works there is sufficient ability for the production of any tar product, in any degree of purity, so soon as the demand and price shall be remunerative. At present, neither the demand nor the price of pure naphthalen is sufficiently encouraging to induce many tar distillers to undertake the production of it. Even were this so, the markets would be overstocked in a few weeks and price would consequently fall.

In tar works, where the refining of benzols, &c., is carried on, pure naphthalen may be easily obtained, without further chemical treatment, by distilling the residues, or foots, from the rectifying stills, and allowing the distillate, say from 0·950 to 1·000 sp. gr., to cool for a day or so; the deposited naphthalen is drained and pressed, re-distilled or sublimed. Naphthalen thus prepared has kept its colour, or rather, it has not become decolourised on exposure to light for some months. The use of MnO_2, $K_2Cr_2O_7$, and other oxidising agents, in conjunction with H_2SO_4, for the purpose of purifying or decolourising tar products, is known to most tar works chemists, and has been used in the laboratory, if not in the works, for many years.

Is it not rather unfair to compare a small sample prepared in the laboratory, probably in glass vessels, with samples prepared in the works on a large scale? Prof. Lunge, from his previous experience in tar works in England, will know how difficult it is to exclude extraneous matter in the form of coal and pitch dust, oily particles, &c., floating in the air of the works, and a very slight trace of these will frequently cause discolouration.

In the description of his process, Prof. Lunge omits to mention that the naphthalin before treatment should be submitted to hydraulic pressure. This is important, inasmuch as samples of naphthalen prepared from light oil residues, &c., by his process, though they would probably remain white for months, would yet retain sufficient cumol, xylol, &c., to render the naphthalen unfit for the preparation of naphthol colours.

In conclusion, would Prof. Lunge kindly state what reasons he has for supposing that aurin may be formed by the oxidation of a mixture of phenol and cresol, as he gives it; thus, $2C_6H_6O + C_7H_8O + 3O = 3H_2O + C_{19}H_{14}O_3$.

Dale and Schorlemmer, in their exhaustive researches on aurin, have come to the conclusion that aurin is formed by the action of nascent CO_2, carbonic dioxide, on phenol, thus— $3C_6H_6O + CO_2 = C_{19}H_{14}O_3 + 2H_2O$.

I cannot reconcile this with the above equation of Prof. Lunge.

The pink discolouration of naphthalen, if "the presence of traces of mineral acids" is another condition for the development of it, may be due to the formation of the red sulpho-salt. It may be interesting to note here that the pink colouration is most frequently observed in tar works on the ends of barrels containing heavy rectified naphthas, the ends of the barrels having previously been "white-washed" with slaked lime. This has led me to attribute the pink colouration on the ends of the barrels to the action of CO_2, absorbed by the CaHO from the atmosphere, on the hydrocarbons which leak through the end of the barrels. I have also noticed that if a sample of impure sublimed naphthalen be mixed with traces of lime dust, the pink colouration is more speedily developed and is more intense than it would be if the lime dust was not present.

SEPARATION AND DETERMINATION OF ALUMINA AND OF THE FERRIC AND CHROMIC OXIDES.

By M. AD. CARNOT.

THE problem of the separation and determination of alumina and ferric oxide is among those which occur most frequently in the analysis of minerals and metallurgical products. Rivot and Sainte-Claire Deville have given methods which are satisfactory when the two oxides can be previously separated from every other substance. But the processes taught by these regretted masters are inapplicable in presence of phosphoric acid, and give questionable results if one of the two oxides is present in very small proportions. These unfavourable conditions are found combined in various ores or minerals and in many products of art—cast-metal, slags, &c. The difficulty is such, especially in cast-iron, that even when the presence of aluminium is suspected, its determination, and even its detection, are rarely attempted.

The author proposes the following method:—The two oxides being dissolved in nitric or hydrochloric acid, there is added pure tartaric acid (about 1 grm.) or potassium bitartrate, and then ammonia in such a quantity that the liquid may become very clear. Ammonium hydrosulphate is then added, the liquid is stirred, and the iron sulphide when deposited is poured upon a filter and washed. The separation is perfectly distinct, provided that the precipitate is not so bulky as to retain by adherence an appreciable proportion of alumina. The iron may then be determined either gravimetrically or volumetrically. In order to determine the alumina there is added, according to its presumed proportion, a quantity of sodium hydrate more than sufficient. The hydrosulphated liquid is then decomposed by hydrochloric acid in slight excess (1 c.c. above the quantity needed for exact saturation), 4 to 5 grms. sodium acetate are then added, and the liquid is raised to a boil. It is kept near 100° for one to two hours, allowing the liquid to become concentrated. The mixture is then poured upon a filter, and washed for a few moments with boiling water.

To remove the tartaric acid with which the precipitate is impregnated, it is re-dissolved in nitric acid, diluted with water, almost neutralised with ammonia, a few drops of phosphoric acid and 2 to 3 grms. ammonium acetate added, and the mixture is boiled for an hour.

The precipitate formed is gelatinous, but there is so little fixed saline matter in the precipitate that after a short washing with boiling water no sensible traces remain in the precipitate. It may be incinerated without detaching from the filter. The phosphate is white, pulverulent, readily soluble in cold dilute nitric acid, and contains 42·04 per cent of alumina.

The precipitation should be effected in liquids not very dilute, and the washing should be effected with a little boiling water, so as to render the loss as slight as possible, for the phosphate is not perfectly insoluble. But 100 c.c.

of boiling water dissolve in reality less than 0·001 grm. of the compound.

The precipitation may even be effected in a complete manner by means of tartaric acid alone, without the addition of an alkaline acetate; but in this case it is more difficult to wash.

The author proposes to return to this method of detecting aluminium in cast-iron.

In order to separate alumina as phosphate from chromic oxide, the latter must first be transformed into chromic acid by fusion with pure potassa and nitre. It is then dissolved, and the liquid is acidified slightly with nitric acid. A little sodium phosphate and 4 to 5 grms. sodium acetate are then added, and the liquid raised to a boil. The aluminium phosphate is precipitated alone. It is washed with a little boiling water in order to remove all the chromic acid, re-dissolved in nitric acid, and the determination of the alumina is completed as above. The filtrate is raised to a boil, and there is gradually poured into it aluminium nitrate enough to throw down all the phosphoric acid. It is boiled for half an hour and filtered. The filtrate when cold is mixed with lead acetate, when the chromic acid is precipitated and weighed as lead chromate.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FROM JULY 1ST TO JULY 30TH, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

August 5th, 1881.

SIR,—We beg to lay before you the results of our daily examinations of the water delivered, from the 1st to the 30th of July, by the seven London water companies taking their supply from the Thames and the Lea. These daily examinations, begun on December 20th of last year, are made under instructions from the water companies, and at their cost. The selection of samples, the methods of analysis, and the form and nature of the reports have rested entirely with us. The samples are taken by a man in our service at places and times which we ourselves appoint.

In 1 only of the 182 samples taken during the month were we able to detect by examining the water in large bulk with the naked eye the minutest trace of matter in suspension.

In Table I. we have recorded the analyses in detail of samples, one taken daily from July 1st to July 30th, inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the 182 samples of water as determined by the colour-meter we have described in a previous report. Practically the waters differ very little in their appearance (even when examined in large bulk) from distilled water; and the occurrence of any cases of inferior colour or of turbidity must be referred to the condition of the household receptacles, not to the condition of the water as supplied.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was noted as "very slightly turbid." The rest were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

Our daily examinations of the water delivered to London during the past month satisfy us of its excellent quality, and of its suitability in every way for the supply of the Metropolis.

We remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ESTIMATION OF POTASSIUM AS PLATINUM SALT.

By DAVID LINDO.

(Continued from p. 78.)

*General Method.**

WEIGHED the solution of KCl in a small light stoppered bottle. Poured into the dish. Rinsed bottle with measured quantity of distilled water intended for dilution (about ten times the volume of KCl solution employed). Added measured quantity of platinic chloride solution (the weight of platinum introduced being about double the weight of KCl used, and in experiments with KCl and NaCl double the weight of the two salts). Evaporated on water-bath. When crusts began to form, removed the dish occasionally from bath, and by communicating a suitable motion to contents, washed the crusts down.

Towards the end of the evaporation removed dish occasionally, and by inclining it spread contents over the bottom. Continued evaporation, until on inclining dish the mass ceased to flow. Added a few drops of water, and evaporated again to same extent (Tatlock). Removed dish and drenched contents with dilute alcohol (80 per cent absolute by weight). 10 c.c. used to drench with in small estimates, 20 c.c. in larger. Mixed contents by communicating rotatory motion to same. Let rest a few minutes. Started filter-pump. Placed crucible with asbestos in position. Poured drench through crucible. Washed precipitate three or four times carefully by decantation, then removed it from dish to crucible with the aid of a feather carefully cut. Rinsed dish repeatedly with a small quantity of spirit, sweeping the rinsings into crucible with feather. To complete the washings, filled up crucible four or five times with spirit. Dried at 130° C.

Experiments with pure KCl were made by this method; the results are given in Table I. In the last ten experiments the residues were alternately moistened with a few drops of water, and evaporated nearly to dryness five or six times. The same plan was adopted in the experiments recorded in Table III. It was abandoned in the method

* Essentially the process employed by Messrs. Teschemacher and Denham Smith, except that I used Gooch's method of filtration, and spirits of wine 80 per cent to wash with, instead of 85 per cent methylated spirit.

finally employed. Between experiments 13 and 14 fou were made with mixed chlorides of K and Na. Ther results of these are given, with others made after, in Table III. With this exception the experiments are recorded in the Tables in the order in which they were made.

TABLE I.

Experiments with Pure Chloride of Potassium.

Expts.		KCl taken.	Weight of Precipitate.	KCl per cent.
A	1	0·62026	2·0295	99·99
A	2	0·43021	1·4078	100 00
A	3	0·42220	1·3813	99·98
A	4	0·46704	1·5281	99·99
A	5	0·39082	1·2777	99·91
A	6	0·23220	0·7616	100·23
A	7	0·23740	0·7765	99·96
A	8	0·21336	0·6994	100·18
A	9	0·66475	2·1748	99·98
A	10	0·29013	0·9513	100·20
A	11	0·27414	0·8977	100·07
A	12	0·23104	0·7556	99·94
A	13	0·21931	0·7179	100·04
B	14	0·26960	0·8812	99·89
B	15	0·24926	0·8140	99·80
B	16	0·22041	0·7211	99·98
B	17	0·23278	0·7598	99·75
B	18	0·25263	0·8263	99·96
B	19	0·24518	0·8024	100·01
B	20	0·21891	0·7155	99·88
B	21	0·21742	0·7110	99·94
B	22	0·24142	0·7894	99·93
B	23	0·23386	0·7644	99·89
B	24	0·25696	0·8430	100·26
B	25	0·22680	0·7410	99·85
A	26	0·42126	1·3814	100·21
A & B	27	0·49321	1·6153	100·09

TABLE II.

Analysis of the Results obtained in the Estimation of Potassium when in the form of Pure Chloride.

No. of Expts.	Highest Result.	Lowest Result.	Average.
27	100·26 p.c.	99·75 p.c.	100·00 p.c.

The precipitate from one of the experiments that had given a high result was carefully examined for traces of copper and iron; none were found. The results of two experiments previously tried may be stated here.

1st Experiment.—1·0588 grm. of the chloro-platinate in scales contained in a porcelain crucible was kept at a temperature of 130° C. for four hours. Allowed to cool, and weighed. No loss. It was then reduced to powder in the crucible (taking every precaution to avoid loss of particles), and weighed again. Loss 0·0002. Heated again to 130° C. until weight remained constant. Further loss, 0·0010 gramme.

2nd Experiment.—1·4773 grm. of the salt in scales treated in the same way lost 0·0014 grm.

These experiments show that the scales (sometimes at least) contain small quantities of fluid impurities mechanically confined, as suspected by the Committee.

The general method was considerably modified in the experiments, the results of which are recorded in Table III. I will describe the various modifications employed as briefly as possible; the method finally adopted will be described more fully further on.

1st Modification.—After pouring off the spirit used to drench with, a little more was added to the precipitate; the latter was then crushed to powder with a large glass rod smooth at the end, washed by decantation, and finished as usual. 80 per cent spirit employed.

2nd Modification.—Alcohol 98 per cent employed to wash with. Crushed precipitate, and proceeded as above.

3rd Modification.—Alcohol 98 per cent used to wash with. Precipitate not crushed, but slightly manipulated with the glass rod.

4th Modification.—Used alcohol of 98 per cent: washed by decantation; removed these washings from receiver. Crushed precipitate, transferred it to crucible, finished washing as usual. Returned last washings through the precipitate four times.

5th Modification.—Used 98 per cent alcohol. Proceeded as in 4th modification, except that last washings were only returned once through the precipitate unless they were opalescent, which was rarely the case. This is essentially the method finally adopted, but it will be described more fully further on.

TABLE III.

Results of Experiments on Mixtures of Pure Chlorides of Potassium and Sodium.

Expt.		KCl taken.	NaCl taken.	Weight of Precipitate.	KCl found per 100 pts. taken.
1st modification—					
A	28	0·44890	0·3786	1·4683	99·96
A	29	0·48126	0·4959	1·5728	99·87
A	30	0·46452	0·4618	1·5194	99·96
A	31	0·41573	0·3691	1·3607	100·02
B	32	0·28632	0·3241	0·9329	99·57
B	33	0·29022	0·2705	0·9484	99·87
B	34	0·29566	0·2553	0·9638	99·62
B	35	0·27297	0·2722	0·8898	99·62
2nd modification—					
B	36	0·34136	0·3623	1·1170	100·00
B	37	0·36843	0·3955	1·2059	100·03
B	38	0·25984	0·2913	0·8506	100·04
B	39	0·27016	0·3177	0·8835	99·94
B	40	0·27654	0·2868	0·9053	100·04
B	41	Rejected, filtrate not quite brilliant			
B	42	0·26269	0·2725	0·8618*	100·26
B	43	0·31618	0·4002	1·0340	99·94
B	44	Rejected, filtrate not quite brilliant			
B	45	Rejected, filtrate not quite brilliant			
C	46	0·28236	0·3400	0·9228	99·87
C	47	0·28092	0·3373	0·9184	99·90
3rd modification—					
C	48	0·26506	0 2161	0·8669	99·95
C	49	0·24090	0·2247	0·7887	100·05
C	50	0·27640	0·3217	0·9050	100·06
C	51	0·28230	0·3023	0·9228	99·90
C	52	0·24298	0·2707	0·7966	100·19
C	53	0·25932	0·2664	0·8496	100·12
C	54	0·23776	0·2790	0·7797	100·22
C	55	0·21784	0·2807	0·7133	100·07
4th modification—					
C	56	0·24397	0·2868	0·7985	100·02
C	57	0·29034	0 3210	0·9491	99·90
C	58	0·21753	0·2212	0·7129	100·15
C	59	0·21815	0·2548	0·7139	100·01
5th modification—					
C	60	0·24874	0·2736	0·8149	100·12
C	61	0·28285	0·3107	0·9252	99·96
C	62	0·24626	0·3207	0·8059	100·00
C	63	0·24875	0·2829	0·8142	100·03
C	64	0·24535	0·2842	0·8032	100·04
C	65	0·23827	0·2829	0·7803	100·08
C	66	0·26158	0·2860	0·8562	100·03
C	67	0·25328	0·2824	0 8282	99·93
C	68	0·27606	0·2761	0·9039	100·06
D	69	0·24544	0·2901	0·8035	100·04
D	70	0·31170	0·3309	1·0188	99·89
D	71	0·25003	0·2678	0·8205†	100·29
D	72	0·24594	0 2478	0·8062	100·18
D	73	0·28087	0·3228	0·9224	100·36
D	74	0 28274	0 2983	0·9267	100·16

* On turning out this precipitate it was found the scales had been very imperfectly crushed.

† A fresh carboy of alcohol was opened and used from here. It was one of the same stock that had been used from in the former experiments. I examined it carefully, but except that it contained slight traces of organic impurities, such as are met with in most samples, I could detect nothing wrong with it.

It will be seen that most of the results obtained, except by the first modification, are very accurate, but three of the earlier experiments were rejected, the filtrates not being quite brilliant. In dealing with such a dense precipitate the slightest opalescence in the filtrates is inadmissible if we wish to obtain thoroughly reliable results. I therefore felt bound to reject these three experiments, though the turbidity was very slight indeed, and the precipitates, when carried to the balance, showed results according well with theory, viz., No. 41, 100·01; No. 44, 99·93; No. 45, 100·08. I had not yet fully learnt that the filtrate could be returned through the precipitate with impunity, and that the annoyance from turbid filtrates might be almost entirely avoided by washing the precipitate by decantation *before* crushing it.

After the analyses were completed the precipitates from experiments Nos. 71 and 72 were submitted to further washing by passing 20 c.c. of alcohol through each of them *five times*; they were then dried again at 130° C., and weighed. The loss of weight sustained in each case was only 0·0002 grm.

As regards the precipitate from experiments No. 73, before weighing, a thin film of perfectly white saline matter was observed on its surface, which looked very much like NaCl. After weighing this film was removed as completely as possible. It tasted like NaCl, and gave a strong Na reaction in flame.

Precipitate from experiment No. 74 did not taste of NaCl, nor were any white particles observed, even with the aid of a lens; but it gave a Na reaction in flame, though not a strong one, and only seen after K reaction had disappeared.

That the precipitates from No. 71 and No. 72 were practically not reduced in weight by further washing with alcohol seems to indicate that the high results obtained in these experiments were also due to the presence of traces of NaCl in these precipitates. As they had been turned out and mixed with other residues they could not now be further examined.

The solution of platinic chloride employed contained (as previously stated) 1 grm. of metal in 20 c.c. The quantities used in these four experiments were as follows:—

Experiment No. 71, 22 c.c.
" 72, 20 "
" 73, 25 "
" 74, 23 "

The platinum was therefore in decided excess of the quantity required to convert all the KCl and NaCl into platinum salts, and the presence of NaCl in the precipitates is therefore difficult to account for.

I may here state that when these experiments were made the platinum had been recovered for the third time, and had reached a high degree of purity. 5 c.c. of the solution, evaporated as nearly to dryness as possible on the water-bath left a residue which dissolved completely in alcohol. The solution was very brilliant. Left in a corked bottle for twelve hours, not the faintest trace of precipitate was observed, even through a lens.

The NaCl employed in all the experiments was a very pure sample prepared by the process of Margueritte; except that it contained a faint trace of sulphate—only apparent after standing some time mixed with chloride of barium: it was chemically pure. With a 10 per cent solution of this salt the following experiments were made. I will first state the quantities of NaCl and volumes of platinic chloride solution (1 grm. metal in 20 c.c.) used in these experiments. All the evaporations were made on the water-bath. 98 per cent alcohol used to dissolve—

	NaCl taken in Grms.	Solution of Platinic Chloride taken in c.c.
Experiment 1	0·2021	20
" 2	0·2500	10
" 3	0·2382	15
" 4	0·4131	20
" 5	0·4237	20

Experiment 1.—Evaporated as nearly to dryness as possible. Left on water-bath about fifteen minutes longer. Added 80 c.c. alcohol. Complete solution. Very brilliant. Deposited nothing after standing twelve hours in closed bottle.

Experiment 2.—Evaporated just to dryness; added 80 c.c. alcohol. Solution not quite brilliant. Deposited small white precipitate after some hours. Precipitate too minute to examine further.

Experiment 3.—Evaporated to dryness; then heated five hours longer on water-bath. Added 80 c.c. alcohol. Solution turbid, and remained so for hours. NaCl had evidently separated, and appeared struggling to re-combine (even in the midst of the strong alcohol) with platinic chloride, the latter being in large excess. After twenty-four hours a small white precipitate fell. This was separated; it tasted like NaCl. Not further examined.

Experiment 4.—Evaporated just to dryness. Added 80 c.c. alcohol. Solution turbid, and after a time deposited a small perfectly white precipitate. Syphoned off fluid nearly to the bottom. Transferred residue to test-tube. Let settle; drained off alcohol; added a little water. Precipitate dissolved completely. The solution was tested as follows:—

1st. Tasted. Distinct flavour of NaCl.
2nd. Heated in flame on platinum wire. Strong sodium reaction.
3rd. Added nitrate silver. Curdy precipitate.
4th. Added chloride barium to a fresh portion. No reaction.
5th. Added one or two drops solution platinic chloride to a fresh portion. Evaporated on slip of glass until crystals formed. Examined these under microscope by polarised light. Beautiful play of colours (Andrew's test for sodium).

Experiment 5.—Evaporated to dryness. Heated five hours longer on water-bath. Added 80 c.c. alcohol. Solution very turbid. Precipitate deposited after some hours. Collected this on asbestos, washed with alcohol, dried, and weighed. Weight 0·0043 grm. Dissolved out with water and tested. Precipitate proved to be NaCl.

It thus appears evident that even in the presence of excess of platinic chloride, reversion of a small portion of the NaCl will sometimes take place.*

That this might occur may have been suspected by others, but I have nowhere seen it distinctly stated that it ever *does* occur.

Whether the reversion takes place in the dry mass or only on addition of the alcohol it is difficult to determine. Prolonged heating on the water-bath seems to promote the change. From experiments already made and others tried since, I feel satisfied that if in the presence of much NaCl, a somewhat larger excess of platinic chloride is used than was employed in the last four experiments, Table 3, and if the mass is not heated too long after it has become dry, on the water-bath, this reversion of NaCl will either not take place at all, or occur to such a trifling extent as to be of no practical importance in the estimation of potassium, and as to render unnecessary the use of aqueous fluids in washing the chloro-platinate.

It will be observed that the experiments modification 3 gave fairly good results. Five of them, indeed, may be considered accurate, and the remaining three are not greatly in excess of the truth. As the precipitates in these experiments were not crushed, but the scales merely broken down slightly with the glass rod, some may think from these results crushing is hardly necessary. I consider, however, that it is unsafe ever to dispense with it if we wish to obtain thoroughly reliable results, for it seems pretty evident that the crystals will at times entrap impurities which the alcohol can remove if it is allowed to reach them. Moreover, these matters appear to be

* Some may think complete combination does not take place in the first instance. That reversion occurs seems more probable. Therefore I have adopted this view here, where the question as to which is the correct one is of no practical importance.

retained occasionally with considerable force by surface adhesion.* The precipitate when reduced to powder forming a compact mass in the crucible, offers considerable resistance to the passage of the fluid, and under pressure of course this will render thorough cleansing more certain.

As regards minus errors when alcohol of the strength employed by me is used to wash with, I know of nothing in the process that can cause them. Therefore, when they appear, I believe they must be due to faulty manipulation.

ERRATUM.—By an error in copying, the factor on p. 77, col. 2, line 18 from bottom, was given as 0·3050. It should be 0·3056.

(To be continued.)

ON SALT-BUSH AND NATIVE FODDER PLANTS OF NEW SOUTH WALES.†

By W. A. DIXON, F.I.C., F.C.S., Technical College, Sydney.

(Concluded from page 79.)

No. 5. *Atriplex sp.*

Oil	1·56
Carbohydrates	38·70
Albumenoids	16·18
Woody fibre	14·48
Ash—CO_2	29·08
	100·00
Nitrogen	2·59
Woody parts of plant	48 per cent.
Edible ,, ,,	52 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	26·54	7·72
Soda	32·29	9·39
Chloride of sodium	6·21	1·80
Lime	14·56	4·24
Magnesia	6·60	1·92
Ferric oxide	1·65	0·48
Sulphuric oxide	3·57	1·04
Phosphoric ,,	4·21	1·22
Silica soluble	4·37	1·27
	100·00	29·08

No. 6. *Kochia pyramidata.* Blue-bush.

Oil	2·14
Carbohydrates	32·63
Albumenoids	19·94
Woody fibre	8·04
Ash—CO_2	37·25
	100·00
Nitrogen	3·19
Woody parts of plant	37 per cent.
Edible ,, ,,	63 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	12·39	4·62
Soda	34·43	12·83
Chloride of sodium	26·67	9·93
Lime	8·75	3·26
Magnesia	7·32	2·72
Ferric oxide	1·28	0·48
Sulphuric oxide	1·11	0·41
Phosphoric ,,	3·98	1·48
Silica soluble	4·07	1·52
	100·00	37·25

No. 7. *Atriplex numularia.* Old man salt-bush.

Oil	2·18
Carbohydrates	42·85
Albuminoids	16·45
Woody fibre	7·24
Ash—CO_2	31·28
	100·00
Nitrogen	2·63
Woody parts of plant	10 per cent.
Edible ,, ,,	90 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	15·69	4·91
Soda	29·57	9·25
Chloride of sodium	30·28	9·47
Lime	8·65	2·71
Magnesia	6·77	2·12
Ferric oxide	0·64	0·20
Sulphuric oxide	3·17	0·99
Phosphoric ,,	4·11	1·28
Silica soluble	1·12	0·35
	100·00	31·28

No. 8. *Chenolea bicornis.* Cotton-bush.

Oil	2·88
Carbohydrates	56·03
Albumenoids	9·18
Woody fibre	24·91
Ash—CO_2	7·00
	100·00
Nitrogen	1·47
Woody parts of plant	6 per cent.
Edible	94 per cent.

Ash Analysis.	On Ash.	On Plant.
Potash	24·73	1·731
Soda	20·17	1·412
Chloride of sodium	8·24	0·577
Lime	24·33	1·703
Magnesia	8·27	0·579
Ferric oxide	1·28	0·090
Sulphuric oxide	3·95	0·276
Phosphoric ,,	5·44	0·381
Silica soluble	3·59	0·251
	100·00	7·000

No. 4 contained or gave up to ether more chlorophyll than any of the others; the quantity of this was generally small, judging from the colour of the solution.

By an unfortunate mistake the whole of the original specimen of No. 6 (the blue-bush) was incinerated. In writing for another specimen, it was suggested that only the more tender parts of the plant need be sent, which suggestion was almost too literally carried out; and as there had been rain between the two gatherings, the plant had entered on its vigorous spring growth, so that the specimen consisted almost entirely of young succulent shoots. This accounts for the high percentage of ash and albumenoids, which are generally higher in immature plants, and the ash would probably be richer in alkaline salts than the ash analysis made on the original specimen shows. Being then in a different stage of development, this analysis does not very well bear comparison with those of the other plants.

The different character of the ash of the cotton-bush from the others was at once shown on charring, as the mass in the crucible slowly burnt away after its removal from the fire, and without further application of heat, and the residue after this spontaneous combustion did not contain above 20 per cent of carbon. It was also noticed that on burning a small portion for the ash determination, it differed somewhat from the other samples, as they all

* See experiments further on.

† A Paper read before the Royal Society of New South Wales.

Tabular Statement of the Composition of European Fodder Plants at the Time of Flowering.

	1. Meadow Hay.		2. Red Clover.		3. Lucerne.		4. Oaten Hay.	
Fat	3·29		3·64		2·94		4·34	
Carbohydrates	48·25		43·79		40·95		49·18	
Albumenoids	10·82		16·70		17·06		10·86	
Woody fibre	30·35		29·17		31·41		30·24	
Ash	7·29		6·70		7·64		5·38	
	100·00		100·00		100·00		100·00	
	On Ash.	On Plant.	On Ash.	On Plant.	On Ash.	On Plant.	On Ash.	On Plant.
Potash	26·20	1·915	32·25	2·161	13·66	1·044	35·24	1·907
Chloride potassium	2·54	0·184	3·06	0·205	2·05	0·156	7·59	0·408
Chloride sodium	11·04	0·805	3·84	0·257	2·60	0·199	2·75	0·148
Lime	13·88	1·002	38·19	2·225	62·83	4·800	11·55	0·621
Magnesia	4·97	0·362	12·04	0·806	4·90	0·374	3·69	0·199
Ferric oxide	0·46	0·033	0·74	0·050	1·03	0·078	0·61	0·033
Phosphoric oxide	6·25	0·455	9·77	0·654	8·15	0 623	10·28	0·553
Sulphuric oxide	5·33	0·388	2·95	0·191	3·90	0·298	2 67	0·144
Silica	28·21	2·056	2·65	0·178	0·81	0·062	25·34	1·363

No. 1. Mean of fifty analyses, representing hay of good quality. Way, "Watts's Dictionary," 2nd Sup., p. 530.
No. 2. Mean of eleven analyses of hay of good quality. Way, *loc. cit.*
No. 3. Mean of a small number of analyses. Way, *loc. cit.*
No. 4. Oats at period of flowering, entire plants. *Arndt. Jarsb. Agricul. Chem.*, 1858-9, p. 24.

burned with a luminous and more or less smoky flame, which was particularly the case with No. 7, diffusing at the same time a peculiar, somewhat fishy odour, whilst it exhibited no such peculiarity either as to flame or odour.

To arrive at the value of a fodder plant, there are many properties which have to be taken into consideration, besides the actual nutritive value as ascertained by analysis, in determining their suitability for grazing, such as the rapidity of growth of the plant, ability to withstand drought and constant cropping, and acceptability in respect to flavour to the cattle. On such points it is beyond my power to speak, but it appears to me a subject of sufficient importance and interest to induce some of those who have the opportunity to make accurate notes on the plants in this direction, and publish the results.

The order in which the salt-bushes proper are considered to stand from a grazier's point of view, are 1st, *A. numularia*, or old man salt-bush; 2nd, the dwarf salt-bush, the others not being so much considered. The cotton-bush is considered to be of great value, both from the fact that the sheep get very fat on it, notwithstanding its unpromising appearance, which reminds one of a half-dried European broom-bush, but also from its ability to withstand long protracted drought. The blue-bush (*Kochia*) is not held in much esteem by the sheep, who do not eat it unless pushed by hunger, and their owners naturally place it low down in the list. This must be entirely a question of flavour, as so far as can be judged from the proximate analysis of the immature plant examined, it must have nearly the same nutritive value as the salt-bushes.

An examination of these analyses, and a comparison with the examples of well-known European fodders given, shows that the whole of these plants stand in a good position with regard to nutritive value.

Like the greater number of the plants of the natural order *Chenopodiaceæ* they contain an extraordinary amount of ash, and its preponderance at once strikes one on looking at the analysis, so that they seem well entitled to their popular name of salt-bushes, although there are only three which contain a very large proportion of common salt.

I can only find one analysis of a plant of the same genus, viz., *A. verrucifera* from the Kergis Steppes, which contains 12·5 per cent ash,* whilst in the specimens examined it ranges from 24 per cent to 31·28 per cent; but in species in other genera, of the same order as *Salsola*, the ash sometimes rises as high as from 30 to 42 per cent, as determined by the same author,† and many of these plants were formerly, and in some cases are even now for local use, of much importance as a source of soda.

In the following columns are given the ratios in which the total ash, the common salt, and the potash stand in relation to the total digestible matter taken as 100, including in that term the oil, carbohydrates, and albumenoids. There is also given the average of the salt-bushes properly so called, omitting the blue-bush, as the analysis was made on a specimen at a different and imperfect stage of growth, and the cotton-bush, as it is a plant of an entirely different character.

The great difference between the salt bushes and European fodders is thus shown conspicuously, and the former are placed entirely by themselves, whilst the cotton-bush, as far as the points considered are concerned, ranges itself with the latter.

Ratios of Digestible Matter of Ash, Potash, and Salt.

	Digestible.	Ash.	Potash.	Salt.
1. Dwarf salt-bush	100	44	7·417	1·024
2. Small salt-bush	100	41	5·607	14·590
3. Salt-bush weed	100	45	8·952	3·581
4. ———	100	47	13·516	5·734
5. ———	100	53	13·751	3·207
7. Old man salt-bush	100	51	7·986	15·403
Average	100	47	9·538	7·689
8. Cotton-bush	100	10	2·541	0·847
Meadow hay	100	12	3·207	1·604
Red clover	100	10	3·524	0·720
Lucerne	100	12	1·969	0·581
Oaten hay	100	8	3·277	0·863

These plants being chiefly used for the pasturage of sheep, we may glance at what effects might be expected to take place on the animals, for there seems little doubt that changes in them must occur from a diet so very different to that on which they have been bred from immemorial time in Europe. Youatt, after speaking of the effect of climate on sheep and their wool, says:—

"Pasture has a far greater influence on the fineness of the fleece. The staple of the wool, like every part of the sheep, must increase in length or in bulk when the animal has a superabundance of nutriment; and on the other hand, the secretion from which the wool is formed must decrease like every other when sufficient nourishment is not afforded."*

Sheep in common with other herbivoræ, appear to

* Göbel, "Watts's Dictionary," 1·474.
† "Watts's Dictionary," v., p. 176.

* Youatt on the Sheep, p

require a large quantity of soluble chlorides, which by evolving free hydrochloric acid in the stomach, or rather in the gastric juice, enables them to digest very considerable quantities of cellulose. According to Bidder and Schmidt,* 1000 parts of the gastric juice of the sheep contain 986·148 parts of water, whilst out of the remaining 13·852 parts 6·0 consist of soluble chlorides and 1·557 of hydrochloric acid. It is seen that the salt-bushes supply these chlorides in large proportion, and we might therefore expect the digestion to be active and to effect the assimilation of the nutritive matter with certainty,

It is in the wool, however, that we should expect the greatest effect to take place from such a diet. Youatt says (page 60) "The abundance and healthiness of the wool is proportional to the amount of yolk." The yolk of wool consists partly of fatty matter combined to a greater or less extent with lime and earthy matter in the form of an insoluble soap, but its greater part consists of a peculiar compound containing potash called "suint." This substance forms about one-third of the weight of raw merino wool and about 14 per cent in ordinary wool, and is readily soluble in cold water. It is used to a considerable extent as a source of potash in France,† where 1000 tons per annum of potashes are obtained from it. Hoffman says‡ that 1000 lbs. of wool yield from 70 to 80 lbs. of pure carbonate of potash, and 5 lbs. to 6 lbs. of sulphate and chloride of potassium, the weight of dry suint being from 140 lbs. to 180 lbs.; and this would give, as an average yield from the suint, 17 per cent of actual potash and 1·5 per cent of chloride and sulphate. From the percentage of suint given this evidently refers to ordinary wool, and as merino wool contains twice as much the actual quantity of potash will be double, and 1000 lbs. of greasy merino wool would carry off about 60 lbs. potash. From the ready solubility of this substance in cold water, it appears probable that much of it may be washed out of the wool by rain and dew during its growth, and that the quantity remaining in the shorn fleece may represent only a small portion of that which has been elaborated by the sheep. This would constitute a considerable drain on the potash obtained by the animal from its food, and it appears evident that the plants we are considering, from their richness in that alkali, would enable the sheep, and especially the merinos, to withstand that drain and produce that abundance of yolk on which it appears the fineness of the wool so much depends. That this is so is shown by the high esteem in which Riverina wool is held, and I hope by an examination of the wool itself to come to a definite conclusion on the matter.

The cotton-bush does not differ much in the matter of the ratios just considered from ordinary European fodders, and it evidently owes its value to the high percentage of carbohydrates which it contains, in which it stands above all competitors, and from which it obtains its fattening properties.

In the following columns are given—first the percentage of digestible matter (organic); 2nd, the ratio of albumenoids to oil and carbohydrates, or of flesh-forming material to fat-forming, the former being taken as 100.

	1.	2.	3.
1. Dwarf salt-bush	58·58	100	287
2. Small salt-bush	57·96	100	565
3. Salt-bush weed	58·64	100	338
4. —— ——	58·60	100	362
5. —— ——	56·14	100	249
6. Blue-bush	54·71	100	174
7. Old man salt bush	61·48	100	211
8. Cotton-bush	68·09	100	641
Meadow hay	62·36	100	478
Red clover	64·13	100	284
Lucerne	60·95	100	256
Oaten hay	64·38	100	482

* "Watts's Dictionary," ii., 822.
† Roscoe and Schorlemmer's "Chemistry," vol. ii., pt. i, p. 9.
‡ "Report on Chemical Products in International Exhibition," 1862, p. 42.

It will be observed that in every case the total amount of digestible matter in the salt-bushes falls below that in the European fodders, with the exception of the old man and the cotton-bush; but this in all cases is due to the greatly increased quantity of ash, as in none of them is the quantity of indigestible organic matter so great. The ratios of carbohydrates to albumenoids vary greatly in the different plants, in some cases fully as low as in the leguminosæ, in some rising as high and higher than in the grasses. The exceptionally low ratio in the case of the blue-bush is undoubtedly due to the very immature condition of the specimen examined. I do not feel warranted in drawing any conclusion from these ratios, taken from such a small number of samples, but place them before you in the hope that some one else, by examining the plants from the different standpoints already indicated, may enable us to arrive at the proper composition of a fodder plant to produce the best result in wool or mutton, or both.

In conclusion, my thanks are due to Mr. Mair, of Groongal, Narandera, and to Mr. Wilson, of the Mercantile Bank, for procuring me the plant specimen; and to Mr. Moore for naming them for me.

NOTICES OF BOOKS.

The Retrospect of Medicine. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxiii., January—June, 1881. London: Simpkin, Marshall, and Co.

This volume contains the usual summary of observations relative to medical science. We cannot say that the facts here recorded are of any especial chemical interest. No new compound, whether natural or artificial, mineral or organic, appears to have been introduced into practice as a remedial agent.

A curious physiological fact here noticed is the occurrence of free sulphuretted hydrogen in the urine of a patient, which otherwise presented no anomalous features. During two years this urine, whenever examined—sometimes within a minute of its emission—was found to contain from 1·4 to 1·9 c.c. per litre. About the same time Dr. C. A. Cameron had the opportunity of observing a young lady, in apparently good health, from whose skin sulphuretted hydrogen was exhaled for about three years. Lead test-papers placed in contact with her skin were blackened in a few hours, as were silver coins, thimbles, &c., carried in her pockets. If she exerted herself the odour was distinctly recognised.

Rheumatism: its Nature, its Pathology, and its Successful Treatment. By T. J. Maclagan, M.D. London: Pickering and Co.

In this work the author first combats, by inductive reasoning, the commonly received opinion that acute rheumatism is simply due to exposure to cold and damp. He next discusses the theory of Prout that the *materies morbi* is lactic acid. He admits that acute rheumatism is attended with an excess of lactic acid in the system, such as is met with under no other circumstances, but he argues that this excess, though one of the phenomena of the disease, is not its cause. Dr. Richardson's experimental result, that the injection of lactic acid into the systems of the lower animals is followed by inflammatory changes similar to those occurring in acute rheumatism, is regarded as doubtful. Nor can lactic acid be assigned as the cause of its own excess.

The author's theory is that the rheumatic poison enters the system from without and belongs to the class of miasms. Rheumatic fever is in many respects strikingly analogous to malarial fever, and is speedily arrested by

large doses, not, indeed, of quinine, but of the salicyl compounds. In connection with this subject Dr. Maclagan enters at some length into the characteristics of miasmata and their distinction from contagia. That the poison of rheumatism has ever been isolated the author does not contend.

Dr. Maclagan seems to have been led to use salicine in the treatment of rheumatism by a somewhat curious course of reasoning. He notes that certain maladies are best combatted by remedies peculiar to the districts where they prevail. Thus ipecacuanha grows, or can grow, in climates where dysentery is most common. Intermittents are most deadly and abundant where the Cinchonaceæ grow most readily. In like manner, he argued that the Salicaceæ—the willows—haunt the districts where rheumatism is most likely to arise. Whether this principle will bear generalising we cannot venture to pronounce.

Salicylic acid the author regards as less safe and trustworthy in its action than salicine. The latter evidently does not owe its remedial action to a supposed conversion within the system into salicylic acid, since the administration of salicine relieves the depression and other symptoms to which salicylic acid gives rise.

New Series of Technological Handbooks.

The City and Guilds of London Institute for the Advancement of Technical Training have concluded to issue a series of text-books for the especial use of students who are about to attend their classes or prepare for examinations. Experience has convined the Council of the Institute that existing text-books are too costly, often unfitted by their style for readers who have not enjoyed the benefit of a learned education, and sometimes compiled by writers who, whilst thoroughly acquainted with the scientific principles of the different arts, were little conversant with their practical working, The series now preparing for publication will be edited by Mr. H. Trueman Wood, B.A., the Secretary to the Society of Arts, who has rendered great services to the Institute, and is thoroughly conversant with the requirements of its students. The following volumes are in preparation:—"Calico-printing, Dyeing, and Bleaching," by W. Crookes, F.R.S., &c.; "Iron and Steel Manufacture," by A. K. Huntington, F.C.S., F.I.C., Professor of Metallurgy at King's College, London; "Telegraphs and Telephones," by W. H. Preece, F.R.S., M. Inst. C.E., Electrician to the General Post Office; "Cotton Manufacture: Part I., Spinning; Part II., Weaving," by R. Marsden, Editor of the *Textile Manufacturer*; "Glass Manufacture: Crown, Sheet, and Plate Glass," by H. Chance, M.A., of the firm of Chance Bros., Birmingham; "Flint Glass," by H. Powell, B.A., of the Whitefriars Glass Works; "Optical and Lighthouse Glass, by J. Hopkinson, M.A., LL.D., F.R.S. The price of each volume will be from 3s. 6d. to 5s.

It must be distinctly understood that the manuals in question will not be "cram books." Their object will be to furnish a practical outline of the various arts, capable of standing the test of actual work, and which the student may fill up in detail from his observations in the factory. The principle of the whole series will be practice combined with theory.

CORRESPONDENCE.

TREATMENT OF HYDROFLUORIC ACID WOUNDS.

To the Editor of the Chemical News.

Sir,—In cases of injury arising from the effects of hydrofluoric acid on the skin allow me to recommend to your notice, treatment with a paste of chalk and water, *and afterwards with a mixture of chalk and olive oil.* This latter mixture allays the pain and suffering considerably, and materially hastens the healing process, as I have had occasion to witness a few days ago in reference to an assistant in my employ. He was treated thus, and now the face-wounds (which were very severe and deep) are healing over, forming a perfectly healthy skin.

If you think proper, I should like to give others whatever benefit may be derived from this experience, through the medium of your valuable journal.—I am, &c.,

A. E. Robinson, F.C.S.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 5, March 5, 1881.

Observations on Pernitric Acid.—M. Berthelot.—Already noticed.

Part Played by Time in the Formation of Salts.—M. Berthelot.—It has been erroneously supposed of late that the reactions of dissolved bases and acids upon dissolved salts are not completed at once, but are, in general, capable of being prolonged for a considerable time, beyond the limit where they cease to be detected by the variations of the thermometer. The chemical equilibrium established so rapidly in dissolved saline systems seems correlated to the electrolytic conductibility which characterises these systems.

Glucoside extracted from Common Ivy.—L. Vernet.—Already noticed.

The Present State of the Rosaniline Question.—A. Rosenstiehl.—The rosaniline question has entered upon a new phase. MM. E. and O. Fischer have arrived at the conclusion that the three NH_2 groups which exist in their molecules, are, over against the carbon of the methane, in the para- position, and in reliance upon the result of direct experiment they deny the formation of rosanilines, either from a mixture of aniline and of pseudo-(ortho) toluidine or from pseudo-toluidine alone. The author takes occasion to distinguish the points upon which he agrees with MM. Fischer, and those which seem to require further examination. The rosaniline which is prepared with a mixture of aniline and ortho-toluidine is always formed in small quantity. In this reaction the aniline plays a part difficult to define, the pseudo-toluidine alone sufficing to produce the red colouring-matter. MM. Fischer consider they have proved that its formation is solely due to the presence of a little para-toluidine in the alkaloid employed. The separation of the last percentages of crystallisable toluidine is not effected without extreme difficulty. It is only by submitting the salts and the aceto-toluide to numerous re-crystallisations that a point is reached where the coloured reactions no longer appear. Such a pseudo-toluidine gives still yields of magenta varying, according to the success of the process, from 5 to 12 per cent. Admitting that the formation of this rosaniline is due to the presence of para-toluidine (at least 3 per cent would be required for such a yield), it results that the alkaloid which escapes the action of the arsenic acid (about 40 per cent) being deprived of its para-toluidine by the first operation would be afterwards unfit for the production of rosaniline. This is not the case. The alkaloid which thus escapes after being freed from small quantities of secondary amines, yields on a second treatment as much magenta as it did the first time. The author has melted pseudo-toluidine which has escaped twice, for the third time along with arsenic acid, and there has been

formed as much magenta as before. This production of colouring-matter is not due to the presence of xylidine or any other analogous body, for the alkaloid employed had distilled over within the interval of single degree Centigrade. From this series of experiments it results that if pseudo-toluidine, alone or mixed with aniline, gives small yields of magenta, these yields are not null. The author does not think that they are due to the presence of para-toluidine, since from 5 to 7 per cent of this base would be needed to produce the 15 to 20 per cent of magenta formed by repeated fusions, which is inadmissible. Either, therefore, the pseudo-toluidine must be transformed during fusion into para-toluidine, or it is capable of forming rosanilines, though to a less degree than its isomer. The author thinks that the conclusion of MM. Fischer, *i.e.*, that the methane of para-toluidine alone is capable of forming rosanilines, is not in absolute agreement with all the facts known. The properties of the different rosanilines are so parallel, as to external appearance, centesimal composition, tinctorial power, and chemical functions, that their non-identity can only be proved by studying the products of their destruction by an energetic reducing agent, hydriodic acid. M. Rosenstiehl considers those rosanilines as distinct which furnish different reduction-products, and inversely. He thus distinguishes para-rosaniline, which is decomposed into aniline and para-toluidine from the rosaniline of commerce, which splits up into aniline, para-toluidine, and pseudo-toluidine. All the conclusions obtained by this method are not, however, trustworthy. The toluene red of Coupier is an instance. Its reduction-products are identical with those of common rosaniline, *i.e.*, aniline, para-toluidine, and pseudo-toluidine. Yet it is obtained from materials free from aniline.

Reserve for Aniline-black.—Horace Kœchlin.—It is known that aniline-black is produced directly upon the fibre by printing a thickened mixture of potassium chlorate, aniline hydrochlorate, and a metallic salt. Rosenstiehl has shown that the reaction is due to the influence of the chlorine produced by the decomposition of the chloric and hydrochloric acids. MM. Storck and Strobel proposed to absorb this chlorine by means of ammonium or potassium sulphocyanide, persulphocyanogen being formed. They prove that by printing upon cotton pieces, colours either with albumen, tannin, or aluminium acetate, mixed in any case with 50 to 60 grms. sulphocyanide per litre, padding in (the materials for) aniline-black, and steaming, the black is not formed where the sulphocyanide has been applied, the latter body acting as a reserve. This process has been in successful action for two years. [A pattern is appended, showing a design with alizarin-red and rose, and Guignet's green (albumen), all mixed with sulphocyanide, then padded in aniline-black, steamed, and soaped.] Sodium hyposulphite, being an antichlore, acts also as a reserve in the dose of 400 grms. at least per litre of colour. Pyrogallic acid, 15 to 20 grms. per litre, also reserves well. The same result is obtained by a process which consists in dyeing the cotton with a manganese bronze, upon which discharge colours are printed, and the bronze is then converted into black by a passage through a salt of aniline. The goods are passed into manganese chloride, then into caustic soda, and oxidised with chloride or chrome. Upon this bronze ground are printed colours containing 400 to 500 grms. per litre of stannous chloride along with the colouring-matter and steamed. The "bistre" styles described by Persoz are thus obtained, and on padding in aniline sulphate the bronze is converted into black. A garnet is obtained in like manner by substituting naphthylamine for aniline.

No. 6, March 20, 1881.

Action of Ozone on the Germs Contained in the Air.—E. Chappuis.—The author has undertaken experiments to show that ozone has the property of destroying the germs capable of occasioning fermentations, putrefactions, and the development of mouldiness. He has filled flasks with beer yeast, and stoppered them, some with cotton which had been exposed to the action of ozone, and the remnant with cotton not so prepared. The latter became turbid in the course of a few days, whilst those stoppered with ozonised cotton remained limpid after twenty days.

Hydrochlorates of the Metallic Chlorates and the Reduction of Chlorides by Hydrogen.—M. Berthelot.—Already noticed.

Fractionated Distillation of Crude Quinoleine and the Oxidation-Products of Lutidine.—Œchsner de Coninck.—The author has obtained lutidine boiling at 165°, and the two collidines boiling at 180° and 195°, in equal quantities. The fraction containing parvoline is about the half of that containing lutidine.

Benzhydrol Acetate.—Camille Vincent.—The author has obtained this compound in crystals, fusible at 41·5°, inodorous, volatile without decomposition, about 300° yielding a colourless liquid, which on cooling solidifies into a crystalline mass.

Russian Chemical Society.—Meeting of Sept. 11/23, 1880.—M. V. J. Ragosine offers the sum of 3000 francs as a prize for the best lamp, capable of burning heavy petroleum oils, of from 0·865 to 0·875 sp. gr.

MM. Beilstein and Kourbatoff announce that they have obtained succinic acid, several liquid acids, and a nitro-product, $C_6H_{11}(NO_2)$, by the action of nitric acid upon that fraction of Caucasian petroleum boiling between 95° and 100°. Hexa-hydro-meta-xylene exists both in American and Caucasian petroleum.

M. Menschoutkine described the influence of isomerism upon the etherification of glycol.

M. Latschinoff announced that a mixture of 4 parts cholalic acid and 1 part of fatty acids is deprived of its taste.

M. Lonatschewsky-Petrounjaka gave the results of the analysis of the water of the Dnieper.

M. Elissafow communicated a memoir on the leucic acid derived from the caproic acid of fermentation.

M. Mendeleeff gave an account of the petroleum deposits of the Caucasus, which he considers the most abundant in the world. He has also explored the sulphur beds of northern Daghestan.

The Influence of Chemical Research upon the Recent Progress of Metallurgy.—V. Deshayes.—The author gives an account of the processes of Hollway and of Thomas and Gilchrist.

Contribution to the History of Sulpholeic Acid.—M. Prud'Homme.—A translation from Runge's *Farben-Chemie*, 1834, describing the preparation of sulpholeic acid and its use as a mordant in cotton dyeing.

No. 7, April 5, 1881.

The Use of the Nitrous Gases in Disinfection and Sanitation.—H. Suilliot.—The author has devised an apparatus for applying the vapours of chamber crystals in disinfection. He finds them more efficacious than ozone.

The Decomposition of Bicalcic Phosphate by Water.—C. Delattre.—On boiling bicalcic phosphate in water the liquid becomes acid, and a notable quantity of phosphoric acid passes into solution. The author has examined the nature of this decomposition, and the limits within which it takes place. The products of the reaction are mono-calcic and tri-calcic phosphates, but the decomposition never becomes complete, as these substances tend to re-combine, forming bicalcic phosphate. A cold solution of the bicalcic salt may be completely decomposed by boiling.

A New Method of Preparing Silicium Oxy-chlorides.—L. Troost and P. Hautefeuille.—The authors caused a current of chlorine mixed with half to one-fifth its volume of oxygen to act upon crystallised silicium in a glass tube.

Magnetic Oxide of Iron.—M. Berthelot.—According to the recent researches of M. Moissan, there exist several

distinct isomeric states of magnetic oxide, differing in the facility with which they are attacked by acids. The author has determined the formation-heat of the most soluble of these compounds.

The Vapour-Density of Iodine.—M. Berthelot.—The laws of Dulong and Petit, of Gay-Lussac, and of Mariotte, constitute the sole scientific base upon which rests the physical determination of molecular weights, and consequently the numeration of the atoms in present theories. In case these laws should not hold good for certain elements the physical definition of the molecular weights of their atoms would become mere conventions. The author has already shown that the experiments of MM. Kundt and Warburg, on the speed of sound in mercurial vapour, are irreconcilable with the totality of the three fundamental laws above mentioned. The experiments of M. V. Meyer, on the decrease of the gaseous density of iodine and the halogens, under constant pressure, but at temperatures widely remote from each other, are still more contrary to the admitted laws. The only law absolutely and universally applicable to the elements is the invariability of the relations of weight, according to which they combine. This notion and that of the energy brought into play in their reactions are the sole firm foundations of chemical science.

On Basic Salts and on Atacamite.—M. Berthelot.—The author considers that atacamite (copper oxychloride) does not result from the substitution of the metallic oxide for the water of hydration of cupric chloride.

The Transformation of Glucose into Dextrine.—MM. Musculus and Meyer.—The substance which the authors formerly obtained on dissolving glucose in sulphuric acid and adding alcohol to the solution presents all the properties, physical, chemical, and organoleptic of a dextrine.

A Cellular Yeast which does not Secrete an Inversive Ferment.—E. Roux.—This new yeast is incapable of setting up fermentation in a solution of cane-sugar.

The Products of Oxidation of Cholalic Acid.—P. T. Cléve.—Not adapted for useful abstraction.

Russian Chemical Society.—Session of October 2/14, 1880.—M. Mendeleeff read the conditions for the Ragosine prize.

M. W. Alexeeff described his experiments on the preparation of pure phenol. Being unable to succeed by Calvert's process he operates as follows:—He adds to commercial phenol 5 per cent of water, and after having melted it, leaves it to stand. The crystals first formed are drained, and after this operation has been repeated three or four times, the product is distilled.

M. Setchenoff gave an account of a relation which he has discovered between the variations in the composition of the air exhaled from the lungs, and the elastic force of the oxygen which it contains.

M. Czech gave in communications on the quantitative valuation of hops and on the wines of the Caucasus.

M. Potilitzine described the deposits of petroleum in the district of Kuban.

No. 8, April 20, 1881.

Certain Facts towards the History of Phosphorescence.—J. Chappuis.—Phosphorus in an atmosphere of pure oxygen is not luminous, but the introduction of a bubble of ozone sets up phosphorescence for a moment. Oil of turpentine prevents phosphorescence, and it possesses the property of destroying ozone. The illumination of phosphorus in oxygen by means of ozone is a means of detecting the presence of the latter.

Contribution to the Study of the Phospho-platinic Compounds.—E. Pomey.—Not suitable for abstraction.

Preparation of Meta-toluidine.—MM. Vienne and Steiner.—The authors have followed the process indicated by M. O. Widman in the *Berichte* of the Berlin Chemical Society, but without obtaining the compound sought.

Formation-Heat and the Combustion-Heat of the Principal Hydrocarbonic Gases and Vapours.—M. Berthelot.—Already noticed.

The Products of Oxidation of Cholalic Acid.—P. T. Cléve.—A continuation of the memoir continued in the last number.

Moniteur Scientifique, Quesneville.
March, 1881.

Process for the Total Destruction of Organic Matters in the Detection of Mineral Poisons.—Dr. A. G. Pouchet.—This process has been already described in the Chemical News.

Hydrometric Method for the Determination of Butter in Milk.—Dr. F. Soxhlet.—This process cannot be intelligibly described without the aid of the accompanying illustration.

Principal Properties of Celluloid.—F. Boekmann.—The various specimens of celluloid examined by the author do not contain true gun-cotton (hexa-nitrocellulose), but the pyroxyline of collodion, perfectly soluble at common temperatures in a mixture of ether and alcohol. Celluloid is not a true definite chemical combination.

The Petroleum Springs.—E. Poulichambaroff.—An account of the petroleum wells of the Caucasus, from an engineering point of view.

Industrial Society of Mulhouse.—Session of December 8th, 1880.—M. Vaucher presented some specimens of Japanese algæ. The best qualities of these weeds resemble what has long been sold under the name of vegetable gelatine for finishing tissues.

M. Noelting presented some notes on anthragallol, on behalf of MM. Bourcart and Georgivies, students in the laboratory of the Chemical School. If anthragallol is heated for twenty-four hours with a large excess of ammonia in a sealed tube to 150°, it forms two derivatives. The one, which constitutes three-fourths of the product, is black, amorphous, and insoluble in all solvents except sulphuric acid. The other crystallises in alcohol in long red needles, and dyes a brownish violet with iron mordants and a reddish violet with alumina, but the shades produced do not bear soaping.

MM. Noelting and Salis have obtained ortho-binitro-cresylol, which they prepared by means of ortho-toluidine, sulpho-conjugating pure ortho-cresylol, and treating the sulphacid formed with nitric acid. They are studying the ethers of the binitro-crysylols and their reduction-products.

M. Noelting presented specimens of garnet and violet colouring-matters prepared by the action of chloro-binitrated and trinitrated benzol, and of chloro-binitro-naphthaline upon rosaniline.

Session of January 12th.—The President read a paper by M. Scheurer, on the imperfection of saponification in the manufacture of soaps. He maintains that a portion both of the fatty acid and of the alkali remain uncombined, and that the latter dulls and impoverishes colours. He recommends that saponification should be effected under pressure.

MM. Noelting and Bourcart, on heating together protocatechuic and benzoic acids, have obtained a colouring-matter which dyes like alizarin, though differing from it in some features.

New Uses of Quasssia Wood.—A decoction of this wood is recommended as a preservative against the bites of mosquitoes, flies, &c., and as a valuable agent for protecting choice fruit trees, &c., from insects.

Two New (?) Colouring-Matters Drawn from the Vegetable Kingdom.—Alneine is an extract obtained from the alder, and "in general from all trees whose sap contains tannic, gallic, saccharine, or mucilaginous principles." It is recommended as superior to the best catechu. [The bark of recently-felled alders was formerly used as a dye for silks.] Ercine is said to be found in the

common heath and the branches of the poplar, and is "destined to displace the extracts of yellow woods used in dyeing."

Antizymotic Action of Benzoic Acid.—M. Schorm.—The author does not describe any experiments on the antizymotic power of this acid, but treats of its different sources, and of the impurities found in its salts.

April, 1881.

Indigotin and its Derivatives.—O. N. Witt and E. Noelting.

Researches on the Affinities of Carbon.—A. Geuther and B. Rose.

Inuline.—H. Kiliani.—These papers are taken from the *Annalen der Chemie*.

Industrial Society of Mulhouse.—At the February meeting, M. C. Koechlin stated that in making soda-soaps by the cold process with emulsive oil, the agitation should not be kept up for more than two or three minutes. It is then necessary for the soap to stand for four or five days to effect complete combination. With potash soaps prolonged agitation is requisite.

MM. Noelting and de Salis have obtained a yellow colouring-matter of the chrysoidine group by the action of diazo-benzol chloride upon para-binitro-cresylol.

MM. Noelting and Witt communicated a summary of the discovery of artificial indigotin and on its future prospects. They consider that ortho-nitro-phenyl-propiolic acid, by means of which indigo can be formed directly upon cloth, may be very serviceable, but that artificial indigotin has little or no chance of competing with the natural product.

Legal Means to be Opposed to the Adulteration of Food.—Dr. E. Vidal.—A summary of legislation on the adulteration question.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 11.

Certain Para-chlor-benzyl Compounds.—C. L. Jackson and J. Fleming White.

Certain Ortho-brom-benzyl Compounds.—C. L. Jackson and J. Fleming White.—These two papers were read before the American Academy of Science, respectively, March 12 and November 12, 1879.

Amido-phenyl-mercaptan, or Sulph-hydraniline.—A. W. Hofmann.—This treatise does not admit of useful abridgment.

MISCELLANEOUS.

The late M. F. Kuhlmann.—We regret to learn, by a courteous communication from the friends of the deceased, the untimely death of this distinguished technical chemist, who has been well styled the worthy successor of his illustrious father.

The Fraudulent Alteration of Cheques.—A recent occurrence is again drawing public attention to this important subject. Early in the year we made favourable mention of the patented process of Mr. A. Nesbitt, F.C.S., who prints upon the cheques grounds or designs capable of being attacked either by acids or alkalies, if such are applied with a view of effacing the writing. We learn that a further and different attempt at the solution of the problem has been made by Dr. Dupré, F.R.S., and M. Hehner, F.C.S., who we believe are chemists to the well-known cheque-printers, Messrs. Skipper and East. The patentees incorporate with the paper-pulp, or print upon the cheque, a mixture of zinc sulphide and lead carbonate. This mixture, white to begin with, retains its colour so long as kept dry, or moistened merely with water. If the cheque is treated with an acid or an alkali, the theory of the inventors is that the zinc sulphide will be decomposed, with the production, respectively, of sulphuretted hydrogen or an alkaline sulphide, and that in either case black sulphide of lead will be produced.

TO CORRESPONDENTS.

Subscriber.—Alizarin is slightly soluble in alkalies; more so in alcohol, and readily soluble in ether, wood-spirit, benzol, petroleum, turpentine, disulphide of carbon, glycerin, chloroform, and acetic acid.

NOTICE.

The Actien-Gesellschaft für Anilin-Fabrikation of Berlin, having been informed that statements are being made to their customers to the effect that the sale and use of ACID RUBINE manufactured by the said Company according to Dr. Jacobsen's Patent, No. 2828, of 11th July, 1879, would constitute an infringment of other patents, they hereby assert that there is no foundation whatever in any such statements, the use and sale of their ACID RUBINE being in no way an infringement of any other Patent.

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SESSION 1881-2.

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II. Department of Science and Engineering.

The Session will commence in these Departments on Tuesday, October 4th. Students will be admitted on and after Wednesday, September 28th. Candidates for admission must not be under 14 years of age, and those under 16 will be required to pass a Preliminary Examination in English, Arithmetic, and Elementary Latin, to be held on the 30th September.

III. Department of Medicine and Surgery.

The Session will commence on Saturday, October 1st. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

IV. Evening Classes.

The Session will commence on Monday, October 10th. New students will be admitted on the Wednesday, Thursday, and Friday preceding, between 6.30 and 9 p.m.

Prospectuses of the several Departments may be obtained at Mr. Cornish's, Piccadilly, and at other Booksellers in Manchester, and they will be forwarded from the College on application.

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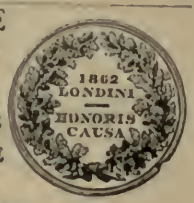

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1135.

ESTIMATION OF POTASSIUM AS PLATINUM SALT.

By DAVID LINDO.

(Continued from p. 89.)

I will now describe fully the

Method Finally Adopted.

Diluted solutions as usual. Mixed with platinic chloride. Evaporated just to apparent dryness, then allowed to remain two or three minutes longer on water-bath.* Removed dish and drenched contents at once with 20 c.c. 98 per cent alcohol. Mixed by communicating rotatory motion; started filter-pump; placed crucible with asbestos in position; connected with pump; poured the fluid through the asbestos. Washed precipitate three or four times by decantation with a small quantity of alcohol, stirring the precipitate up with a feather.† Cleansed dish at the same time of excess of platinic chloride and sodium salt. Poured a little alcohol on precipitate in dish and set it aside. Removed crucible. Stirred up filtrate from the bottom with feather, and examined carefully. If the faintest opalescence was observed, passed filtrate again through the asbestos. Having obtained it quite bright, the filtrate was removed from the receiver. Crushed the precipitate in the dish to powder with a large glass rod, the end of which had been fused before the blowpipe. In crushing the precipitate care was taken to break down even the smallest aggregations.‡ Rinsed the rod with alcohol, and waited a minute or two for precipitate to settle somewhat. Started pump again, connected it with receiver and crucible, poured the fluid through the asbestos, and transferred precipitate with the aid of the feather to crucible. Particles of precipitate adhering to the feather were washed into the crucible with alcohol delivered from a small dropping bottle. Rinsed dish repeatedly with small quantities of alcohol, sweeping the rinsings with all remaining traces of precipitate into crucible with the feather. Filled up crucible two or three times with alcohol. These last washings were found to measure 25 to 35 c.c., and had a faint yellow tinge; they were removed from the receiver, and passed again slowly through the precipitate, filling up crucible by pouring gently down the side, allowing fluid to drain off, and pump to suck precipitate a few seconds before adding a fresh portion of fluid. Removed crucible, stirred up filtrate with feather, and examined carefully; if the slightest opalescence was noticed, the filtrate was passed again through the precipitate, when it was always obtained beautifully bright. Finished by filling crucible once with alcohol. Dried at 130° C. Although the absolute necessity for passing the last washings through the precipitate twice will rarely occur, it might always be done with advantage, as it ensures thorough washing and can never do harm.‖

The results obtained by this method (which differs very slightly from Modifications 2, 4, and 5) are given in Table IV. 4½ in. dishes were used in all these experiments. The total washings, including the drench, were found to average 60 c.c. I have given in the table the volumes of platinic chloride solution employed. Strength 1 grm. of metal to 20 c.c. The manipulations are very simple, and rapidly performed. Working with two crucibles, I have easily made six estimates in a day.

Table IV.

Results of Experiments on Mixtures of Pure Chlorides of Potassium and Sodium by the Method finally adopted.

Expts.	KCl taken.	NaCl taken.	Weight of Precipitate.	KCl Obtained per cent.	Volume of Platinic Sol. used in c.c.
D 75	0·22368	0·2515	0·7323	100·05	24
D 76	0·22020	0·2331	0·7204	99·98	23
D 77	0·23648	0·2446	0·7748	100·13	25
D 78	0·24380	0·2593	0·7982	100·05	26
D 79	0·20222	0·2512	0·6620	100·04	28
D 80	0·24452	0·2435	0·8008	100·08	30
D 81	0·21012	0·2303	0·6884	100·12	28
D 82	0·25030	0·2656	0·8198	100·09	32
D 83	0·41358	0·1141	1·3534	100·00	22
D 84	0·38264	0·1059	1·2524	100·02	20
D 85	0·40058	0·1042	1·3106	99·98	21
D 86	0·39296	0·0938	1·2871	100·10	20
D 87	0·36440	0·1035	1·1933	100·07	20
D 88	0·41402	0·1147	1·3553	100·04	22
D 89	0·35678	0·0890	1·1677	100·02	19
D 90	0·39120	0·1145	1·2809	100·06	21
D 91	0·38418	0·1089	1·2579	100·06	20
D 92	0·41003	0·1218	1·3422	100·04	22
D 93	0·46396	0·1223	1·5193	100·07	23

I consider these results justify the conclusion that the error in excess when this method is employed will rarely reach 0·15 of one per cent in the separation of KCl from considerable quantities of NaCl (up to 50 per cent), and seldom amount to 0·10 when smaller quantities (up to 20 per cent) of NaCl are present, the quantity of mixed chlorides taken for analysis in each case being about 0·5 grm., and the results compared with 100 parts of potassium salt taken.

The KCl taken may be stated as constituting so much per cent of the mixture of the two chlorides employed, and the KCl found may be stated in the same manner. In practice it must be reported in this way. The extent to which the errors will appear reduced by this method of comparing the results is shown in Table V.

Table V.

Comparison of the Actual Composition of Mixtures of Potassium and Sodium Chlorides, with the results obtained.

Expts.	P.c. KCl taken.	P.c. NaCl taken.	P.c. KCl obtained.	Error.
1st modification—				
28	54·25	45·75	54·22	− 0·03
29	49·25	50·75	49·19	− 0·06
30	50·15	49·85	50·13	− 0·02
31	52·97	47·03	52·98	+ 0·01
32	46·90	53·10	46·70	− 0·20
33	51·76	48·24	51·69	− 0·07
34	53·66	46·34	53·46	− 0·20
35	50·07	49·93	49·88	− 0·19
	Average			− 0·10
2nd modification—				
36	48·51	51·49	48·51	
37	48·23	51·77	48·24	+ 0·01
38	47·15	52·85	47·16	+ 0·01
39	45·96	54·04	45·93	− 0·03
40	49·09	50·91	49·11	+ 0·02
41	Rejected			
42	49·08	50·92	49·21	+ 0·13
43	44·14	55·86	44·11	− 0·03
44	Rejected			
45	Rejected			
46	45·37	54·63	45·31	− 0·06
47	45·44	54·56	45·40	− 0·04
	Average			0·00

* I have confirmed the observation of Precht that when the evaporation is carried to dryness, the chloro-platinate of sodium is more readily dissolved by the alcohol, but *prolonged* heating of the dry mass must be avoided, for the reason already given.

† A stiff feather should be selected, best from the wing of a duck. It is stripped to within 2 inches of the tip, and then carefully trimmed with a sharp pair of scissors.

‡ I suppose I need hardly point out that reducing the chloro-platinate to the state of a crystalline powder, after it has been deposited slowly by evaporation from a dilute solution, and washed by decantation, is a very different thing to precipitating it in a pulverulent state in the midst of extraneous matters from a concentrated solution.

‖ That the filtrate appears colourless is not a certain indication that the washing has been sufficient.

Expts.	P.c. KCl taken.	P.c. NaCl taken.	P.c. KCl obtained.	Error.
3rd modification—				
48	55·09	44·91	55·06	− 0·03
49	51·74	48·26	51·77	+ 0·03
50	46·21	53·79	46 24	+ 0·03
51	48·29	51·71	48·24	− 0·05
52	47·30	52·70	47·39	+ 0·09
53	49·33	50 67	49·39	+ 0·06
54	46·01	53·99	46·11	+ 0·10
55	43·70	56·30	43·72	+ 0·02
	Average			+ 0·03
4th modification—				
56	45·96	54·04	45 97	+ 0·01
57	47·49	52·51	47·44	− 0·05
58	49·58	50·42	49 66	+ 0·08
59	46·12	53·88	46·13	+ 0·01
	Average			+ 0·01
5th modification—				
60	47·62	52·38	47·68	+ 0·06
61	47·65	52·35	47·64	− 0 01
62	43·44	56·56	43·44	
63	46 79	53·21	46·80	+ 0·01
64	46·33	53·67	46·35	+ 0·02
65	45·72	54·28	45·75	+ 0·03
66	47·77	52·23	47·78	+ 0·01
67	47·28	52·72	47·25	− 0·03
68	50·00	50·00	50·03	+ 0·03
69	45·83	54·17	45 85	+ 0 02
70	48·51	51·49	48·45	− 0·06
71	48·28	51·72	48·42	+ 0·14
72	49 81	50 19	49·90	+ 0·09
73	46 53	53·47	46·69	+ 0·16
74	48·66	51·34	48·74	+ 0·08
	Average			+ 0·04
Method finally adopted—				
75	47·07	52·93	47·10	+ 0·03
76	48·58	51·42	48·57	− 0 01
77	49·16	50·84	49·22	+ 0·06
78	48·46	51·54	48·49	+ 0·03
79	44·60	55·40	44·62	+ 0·02
80	50·10	49·90	50·15	+ 0·05
81	47·71	52·29	47·77	+ 0·06
82	48·52	51·48	48·56	+ 0·04
83	78·38	21·62	78·38	
84	78·32	21·68	78·34	+ 0·02
85	79·36	20·64	79·34	− 0 02
86	80·73	19·27	80·81	+ 0·08
87	77·88	22·12	77·94	+ 0·06
88	78·30	21·70	78·34	+ 0·04
89	80·03	19·97	80·05	+ 0·02
90	77·36	22·64	77·41	+ 0·05
91	77·91	22·09	77·96	+ 0·05
92	77·10	22·90	77·13	+ 0·03
93	79·14	20·86	79·20	+ 0·06
	Average			+ 0·04

The highest result obtained in nine experiments published by the committee on the separation of KCl from large quantities of NaCl by Tatlock's process is 99·97 and the lowest 99·20, the average being 99·58. It should be observed, however, that in four of these experiments the quantities of material taken for analysis were measured, instead of being weighed. In four experiments with smaller quantities of NaCl the results obtained were slightly above the truth. The results obtained in five experiments made with *pure* KCl by the same process were accurate. The committee concludes from these, that the chloro-platinate is practically insoluble in a strong aqueous solution of platinic chloride, prepared, I presume, by the method described in the report.

I employed the same process, and freed the reagent of HCl, as completely as this could be done at the temperature of the water-bath. It certainly was not quite neutral, nor, I presume, was that employed by the committee. My solution contained 5 grms. of metal in 100 c.c., the committee's about 6 grms. in the same volume.

Ten experiments were made with pure KCl by Tatlock's method. In the first six I digested the precipitate in the solution containing 1 grm. platinum in 20 c.c.; in the last four, in a solution double this strength, made by concentrating the other. The manipulations will be described as briefly as possible.

Diluted solution. Mixed with excess of platinic chloride (platinum about double the weight of KCl employed). Evaporated just to dryness. Moistened with water. Evaporated to same extent again. Added 40 m.m. platinic chloride solution. Mixed well. Left to digest in the cold (in first two experiments for half an hour, in the others for an hour or an hour and a quarter), stirring occasionally with a thin glass rod. Poured the aqueous fluid through the asbestos, and washed with 10 minims more platinic solution. Let the pump suck well. *Removed aqueous filtrate from receiver*, and rinsed out latter with alcohol. Washed precipitate by decantation with 98 per cent. alcohol, and transferred it to the crucible. Washed with more alcohol. Last washings returned once through precipitates. The latter were never crushed. The results are given in Table 6. The alcoholic washings averaged about 42 c.c.

TABLE VI.

Experiments with Pure Chloride of Potassium. Tatlock's Modification.

Expts.	KCl taken.	Weight of Precipitate.	KCl Obtained per cent.
E 94	0·47066	1·5386	99·90
E 95	0·50867	1·6624	99 87
E 96	0·47420	1·5476	99·74
E 97	0·50878	1·6598	99·70
E 98	0·45253	1·4760	99·68
E 99	0·47730	1·5555	99·59
E 100	0·54489	1·7800	99·83
E 101	0·53624	1·7495	99·70
E 102	0·58945	1·9260	99·85
E 103	0 55248	1·8040	99·79

The aqueous filtrates vere very brilliant, but invariably produced marked turbidity when mixed with a sufficient volume of alcohol. After a time a small precipitate of chloro-platinate subsided, showing, of course, that a small quantity of the original precipitate had been dissolved. If the aqueous filtrate is allowed to mix with the alcoholic washings, a turbid fluid will result. If the volume of alcohol is sufficient, if time is allowed for the precipitate to form, the fluid stirred up, and returned through the bulk of the precipitate until it passes clear, accurate results may be reached at last, but this would be rather an awkward way of arriving at them.

Having found by repeated trials that it was quite unnecessary to place the crucible and precipitate in a desiccator to cool before weighing, the method adopted in all the experiments Tables 3, 4, 6, and in most of those in Table 1, was to place the crucible and contents, after removal from the air-bath, under a glass shade to cool. When quite cold, wiped the outside of the crucible with a soft dry cloth, and weighed deliberately. The weighings in experiments (further on) on the solubility of chloro-platinate, and in taking the tare of the crucibles and feltings in all experiments, were made in the same manner.

The precipitate is not in the slightest degree hygroscopic, and the constancy in weight which it exhibits is very remarkable. I have repeatedly left it (in scales or powder) in a crucible loosely covered, under a glass shade from one day to the next, and sometimes longer (the amount of moisture in the atmosphere varying considerably), and as a rule found the weight remain constant to 0·0001 grm. I have done the same with the asbestos feltings with particles of the precipitate adhering to them, and with the same result.

(To be continued.)

ON A

MODIFICATION OF THE ELECTRIC LAMP.

By M. JAMIN.

THE lamp which the author has made known is of very small bulk and can be placed either in a vacuum or in inert gases within a globe entirely closed. Among the gases which have no action on the carbons rank nitrogen, carbonic oxide, marsh-gas, and probably carbon disulphide. The majority of the others are decomposed. Common air behaves in a peculiar manner. The vessel is first filled with ruddy vapours from the combination of oxygen and nitrogen under the electric influence. This compound is soon destroyed and the gas becomes colourless again. It is evident that the hyponitric acid is decomposed to supply oxygen to the carbon. Ultimately nothing remains but nitrogen and carbonic oxide.

During this time the electric arc undergoes corresponding changes. As long as there are red vapours, it varies at once in its intensity and its colour, rising and descending along the points. As the gas becomes decolourised the flame becomes fixed and changes its colour. When all the chemical transformations are completed, it is reduced to a well-defined arc of a bluish-green, unmixed with other colours. It becomes absolutely fixed without any fading in its intensity or variation in its colour or position. In no other case has the author remarked so complete a fixity which necessarily involves the same invariability in the lustre of the points. This circumstance will probably obviate the irregularities met with in all points.

This spectrum is traversed by an incredible quantity of very fine and almost regular lines. It presents a very unequal brightness in its different parts. There are seen four great maxima, which begin abruptly on the less refrangible side with a very brilliant line, which is repeated at equal distances, growing feebler. These maxima are in the yellow-green, the green, the blue, and the violet. They alone remain visible if the light is diminished. We recognise then the spectrum of the blue flame of alcohol or of gas; that of the carburetted gases traversed by the spark of Ruhmkorff's coil, and lastly, that of the recent comet, as studied by M. Thollon: it is the electric spectrum of the vapour of carbon rendered incandescent without burning.

In the air the case is different; the carbon burns, the arc is red, and we see alternating at regular intervals the foregoing spectrum and another due to combustion and totally different; it presents a splendid assemblage of brilliant rays due to the combustion of the metals present in the carbon. It is evident that in an inert gas, we have a simple and purely electric phenomenon; that the arc is a current; that we can direct it and keep it invariably at the points by electro-magnetic action. Hence the remarkable fixity of the light. In the free air, on the contrary, the phenomenon is complex. There is still a current which we may fix, but there is also the combustion of the carbons over which we have no power, and which varies from moment to moment from the want of homogeneity in the carbons, occasioning those oscillations with which the electric light is justly charged.

If we operate in confined air, we observe at first the spectrum of combustion. As soon as the chemical transformations begin, the electric spectrum appears; the two are never seen at once, but succeed each other alternately; little by little the duration of the combustion spectrum decreases, whilst the electric spectrum is prolonged, and finally becomes persistent.

It is very remarkable that in the two cases the arc is characterised by spectra so dissimilar, and that the oscillations of the light are merely indications of the passage from one spectrum to the other.

It is still more important that as the carbons cease to burn they cease to wear out. When operating in the air with a medium current, there is expended 0·16 metre "candle" per hour, and as there are five candles of 0·32 metre per lamp, it lasts 10 hours, or one night. In the closed apparatus, as the gas is transformed, the consumption decreases rapidly, and is reduced to 0·002 metre per hour. Each candle lasts 100 hours; each lamp 800 hours, or 80 nights of 10 hours each. We may say that the electric light is rendered perpetual; that it is enough to replace the carbons when the lamp requires cleaning; that their cost is almost abolished, and their quality rendered indifferent; that all daily attention is suppressed, and then the light acquires a steadiness hitherto unknown. It must be added that the lamp becomes ignited spontaneously as soon as the current is closed.

In practice, it is requisite to reduce as much as possible the dimensions of the glass globe containing the burner; carefully to prevent the outer air from entering when the apparatus is cold, whilst allowing the interior gas to escape by means of a valve, when the lamp is in action.—*Comptes Rendus.*

NOTE CONCERNING THE ACTION OF THE ORGANIC MATTER NOT SUGAR OCCURRING IN CANE AND BEET PRODUCTS, ON ALKALINE SOLUTION OF COPPER OXIDE.

By J. H. TUCKER.

IT has been asserted that the organic matters present in impure commercial sugars and syrups have a considerable reductive effect on the copper solution employed in Fehling's method and its various modifications for the estimation of invert sugar. To avoid this supposed source of error, it has accordingly been recommended that sugar solution, before testing, should be treated with excess of basic lead acetate, filtered, the metallic salt remaining in solution precipitated with sulphurous acid, and the resulting liquid after filtering again used for the sugar determination.

In order to prove whether the organic matters acted as asserted with Fehling's solution, the author has made some experiments on the most impure saccharine material obtainable from a variety of sources. The manner of conducting the experiments was as follows:—The hot solution of the substance operated upon was treated with excess of basic lead acetate and the precipitate washed thoroughly with a large excess of hot water. To be assured that no sugar should remain in the precipitate as lead sucrate, the washed magma, after diffusion through water, was saturated with carbonic acid by allowing the gas to bubble through the diffused mass for six or eight hours, or longer. After this treatment the precipitate was again well washed, and then, after mixing with water, decomposed by sulphuretted hydrogen, the lead sulphide filtered off, and the resultant dissolved organic matters evaporated to dryness at a gentle heat and weighed. The substance thus separated was heated with Fehling's solution (Violette's), near the boiling-point, for some minutes, the resulting cuprous oxide, converted into cupric oxide, and weighed, special correction being made for the filter-ash on account of the amount of copper retained.

The results are given below; 0·100 gramme organic matter of the different origins given caused the reduction of the following amounts of copper oxide:—

West India molasses	0·027	gramme	CuO
Residual syrup from sugar-refining	0·030	,,	,,
Beet molasses	0·0124	,,	,,
Muscovado raw sugar	0·0246	,,	,,
Manilla	0·0170	,,	,,
0·100 gramme invert-sugar reduces	0·2206	,,	,,

In order to test whether any sugar might have been retained in the precipitates before decomposition with

lead, a control experiment was made by adding tartrate of soda and potash to a solution of pure invert-sugar, and precipitating with basic acetate of lead. This produced a voluminous precipitate similar to that thrown down from impure sugar solutions. The tartrate of lead was treated in the same manner as the compounds of lead and organic matter, as detailed above, and the tartaric acid obtained after the decomposition with sulphuretted hydrogen was heated with the copper solution.

0·100 gramme reduced 0·002 gramme CuO.

From this it may be concluded that little or no sugar was retained in the organic lead compounds operated upon.

As a general result of these experiments, it may be proved by calculation that organic matters in impure sugars have too small an influence upon the results of the copper test to make it necessary to remove them from the sugar solutions in most cases. When the saccharine material contains a considerable proportion of these compounds, for very accurate work such removal may be desirable.

ON THE RELATION OF MOISTURE IN AIR TO HEALTH AND COMFORT.

By ROBERT BRIGGS, C.E., Cor. Mem. Am. Inst. of Architects.

IN continuation of the paper read before the American Institute of Architects,* it is desirable to support the argument for the impracticability of attaining the full summer condition of humidity, for air in winter which has been warmed to the temperature of comfort, by more extended computations than could be presented to an audience, or brought within the scope of comprehension of the listener or the casual reader. The single example with specified relations which was taken showed, on calculation, that nearly as much heat would be expended in supplying vapour for the usual hydration of air of usual humidity and of 34° temperature (which air was heated to 70°) as was expended in heating the air itself.

The temperatures and humid condition of about 69 per cent assumed, being the averages of nature, out of doors for three warm or three cold months in the city of Philadelphia, in 1844, as reported by Prof. Bache. It occurs, accidentally, that the exact conditions of temperature and humidity chosen for an example give the ratio of heat demanded for the two purposes incident to warming air as unity, white this ratio, for other temperatures and degrees of humidity, will be found to vary materially. For the purpose of exhibiting more completely the general case, the accompanying table has been prepared to show what quantities of heat are demanded for heating, or are given out in cooling air of 70 per cent humidity, from various temperatures (from 0° to 100°) to 70°, in direct comparison to the quantities for vapourisation or condensation of water to procure the condition of 70 per cent humidity to the air of 70°. When 70° and 70 per cent humidity may be accepted as the American summer condition of comfort for the air, it being asserted that 70°, with 80 per cent, or more, of humidity, is close and enervating, while 70°, with 60 per cent, or less, of humidity, is fresh and cool, and demands heavy clothing to preserve the comfort of the individual—a proper and necessary demand in winter.

The figures relating to weights in the table (see next page) refer to 1000 cubic feet (a cube of 10 feet side) for a unit, to avoid the repetition of 0's in decimals; by multiplying any value by 7, the weights per cubic foot in grains will be found. All the weights are in pounds avoirdupois and decimals. The volumes are in cubic feet.

Columns II. and III. are derived from Regnault's data; weight of one cubic foot of dry air = 0·080728 pound = 12·387 cubic feet per pound; and rate of expansion = 0·002039 volume for each degree Fahrenheit from 32° = 0·025315 cubic foot per pound from 32°.

Column IV. is taken from Guyot's tables, Regnault's data, slightly corrected by differences.

Column V. is derived from $W = \frac{0{\cdot}622}{29{\cdot}922} \times$ value of Column III. × value of Column IV., where 0·622 = specific gravity of vapour in air of the same tension; and 29·922 = inches of mercury column which measures the tension of air in Column II.

Column VI. is obtained directly from Column V., as indicated in caption.

Column VII. is obtained by taking the difference of weight of the volume of vapour in the air from that of the air which it displaces, and deducting their difference from the respective values in Column III. The values in Column VII. agree as closely as could be expected with results in Glaisher's tables.

Column VIII. is obtained by deducting weight of vapour. Column V. from Column VII.

Column IX. is obtained by taking the ratio of quantity of dry air in the several values of Column IX., with the value at 70° (= 73·63 pounds) as a unit, and dividing by this ratio the values in Column VI.

Column X. is obtained by taking 70 per cent of $\frac{F}{29{\cdot}922}$, where F is the tension of vapour possible to exist at the given temperature, as given in Column IV., and 29·922 is the tension of the atmosphere. It should noticed that this column has its units in percentages: the first value for instance, is 11·100 of a per cent.

Column XI. is obtained by making a computation of three columns for saturated air, like VII., VIII., and IX., and thus ascertaining at what degree of temperature the values in Column IX. coincide with those in the same column for saturated air. This column closely agrees with Glaisher's, varying two degrees higher at 15° and corresponding at 80°.

Column XII. is taken from Glaisher's tables at 70 per cent., and is sufficiently exact for use.

Column XIII. is obtained by taking the difference between the quantity of vapour in air of 70° Fahrenheit, and that in the several values given in Column IX.

Column XIV. is obtained by multiplying 0·07363 pound (the quantity of dry in a cubic foot of air of 70° Fahrenheit and 70 per cent. humidity) by 0·238 (the specific heat of air), adding to this value that of the amount of the several values in Column IX. multiplied by 0·475 (the specific heat of vapour), and then multiply the sums of the above by the number of degrees from 70° which the air is to be heated or cooled.

Column XV. is obtained by multiplying the values of Column IX. (the vapour to be supplied or removed) by 1065 °= the latent heat of steam from and at 70° and dividing the result by 1000, so as to give the heat of vapourisation belonging to one cubic foot of air at 70°.

A careful study of the table, with comparisons of the values given in the several columns, will readily allow any student to find the fullest corroboration of the views expressed in the original paper; but for the convenience of the general reader it may be well to exhibit some of the results. Thus, calling attention to Column XI. it will be seen that the air of saturation at 60° becomes, by heating, that of 70° and 70 per cent humidity; showing a close approach of English and American humid conditions to the comfortable condition in either case. Again, the temperature of saturation for air of 80°, with 70 per cent humidity, is 69·5°; consequently, air of above 80° of the usual humid condition of our climate in summer, will become a mist and rain, unless its moisture be absorbed by some non heat-giving absorbent. If such air is to be reduced to the 70° standard of comfort, by means of surfaces cooled by currents of water, such surfaces must have a temperature at least below 60°, and probably 10° below that point, to abstract, by condensation, the moisture from the air. The heat demanded for condensation, therefore, will be increased some 20° below that of cooling the air, but as the latent heat of

* See CHEMICAL NEWS, vol. xliii. p. 253 *et seq.*

TABLE.

VOLUME AND WEIGHTS OF AIR AND VAPOUR OF HUMIDITY—TEMPERATURES OF SATURATION AND DEW POINT—HEAT TO BE EXPENDED IN WARMING OR COOLING AIR OR VAPOUR TO THE TEMPERATURE OF 70° FAHRENHEIT AND CONDITION OF 70 PER CENT HUMIDITY.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
Temperatures in degrees F.	Volume of dry Air to one Pound. Barometer 29·922 inches.	Weight of dry Air per 1000 cubic feet. Barometer 29·922 inches.	Force of Vapour in inches of Mercury Column.	Weight of Vapour in 1000 cubic feet = quantity of Vapour in saturated Air.	70 per cent of weight of Vapour in 1000 cubic feet = quantity of Vapour in air of 70 per cent humidity.	Weight of 1000 cubic feet of Air of 70 per cent humidity including its vapour. Barometer, 29·922 inches.	Weight of dry Air in 1000 cubic feet of Air of 70 per cent humidity. Barometer, 29·922 inches.	Weight of Vapour accompanying 7·363 lbs. of dry air at given temp., and 70 per cent humidity. Barom. 29·922 in.	Percentage of volumes of Air of 70 per cent humidity displaced by the presence of aqueous vapour. Barom. 29·922 inches.	Temperatures of saturation in degrees F. = Dew Point of Air of various temperatures, and 70 per cent humidity.	Temperature of indication of Wet Bulb Thermometer, taken from Glashier's tables.	Weight of Vapour to be supplied or taken from 1000 cu. ft. of Air, when brought to 70° F. to make quantity needed for 70 per cent humidity.	Heat units for warming or cooling 0·7363 lb. of Air with its accompanying Vapour from given temp. to 70° F.	Heat units demanded for vapourisation or condens. of vapour to give 70 p.c. humidity to 1 cub. ft. of Air of 70° F.
0	11·577	86·38	0·045	0·081	0·057	86·35	86·29	0·048	0·11	..	..	0·749	1·228	0·797
5	11·704	85·44	0·054	0·095	0·067	85·40	85·33	0·058	0·13	..	..	0·739	1·141	0·787
10	11·830	84·53	0·067	0·118	0·082	84·48	84·40	0·072	0·16	1·1	8·8	0·725	1·054	0·772
15	11·957	83 64	0·085	0·148	0·104	83·58	83·47	0·092	0·20	7·3	13·9	0·705	0·966	0·751
20	12·083	82·76	0·108	0·186	0·130	82·68	82·55	0·116	0·25	12·4	18·9	0·681	0·879	0·725
25	12·210	81·90	0·136	0·232	0·162	81·80	81·64	0·146	0·32	17·2	23·5	0·651	0·792	0·693
30	12·336	81·06	0·169	0·285	0·199	80·94	80·74	0·182	0·40	21·8	27·7	0·615	0·704	0·655
32	12·387	80·73	0·183	0·308	0·216	80·60	80·38	0·198	0·43	23·6	28·8	0·599	0·670	0·638
35	12·463	80·24	0·207	0·345	0 242	80·10	79·85	0·223	0·49	26·5	25·0	0·574	0·617	0·611
40	12·590	79·43	0·251	0·415	0·290	79·26	78·96	0·271	0·59	30·8	30·1	0·526	0·529	0·560
45	12·716	78·64	0·302	0·494	0 346	78·43	78·08	0·326	0·71	35·5	34·6	0·471	0·432	0 501
50	12·843	77·87	0·362	0·587	0·411	77·62	77·21	0·392	0·85	40·3	45·0	0·405	0·353	0·432
55	12·969	77·11	0·433	0·695	0·487	76·82	76·33	0·470	1·01	45·1	49·0	0·328	0·266	0·349
60	13·096	76·36	0·517	0·821	0·575	76·02	75·44	0·561	1·21	50·0	54·0	0·236	0·178	0·251
65	13·222	75·63	0·616	0·968	0·678	75·22	74·54	0·669	1·44	54 9	58·5	0·127	0·088	0·136
70	13·349	74·91	0·732	1·138	0·797	74·43	73·63	0·797	1·71	59·8	63·0	0·000	0·000	00·00
75	13·476	74·21	0 867	1·336	0·935	73·65	72·71	0·946	2·03	64·7	68 0	0·149	0·090	0·159
80	13·602	73·52	1·023	1·562	1·094	72·86	71·77	1·121	2·39	69·5	72·5	0·324	0·181	0·345
85	13·729	72·84	1·203	1·822	1·275	72·07	70·80	1·326	2·82	74·2	77·5	0·529	0·272	0·563
90	13·855	72·17	1·410	2·117	1·482	71·28	69·80	1·563	3·30	78·9	82·5	0·766	0·365	0·816
95	13·982	71·52	1·647	2·452	1·716	70·49	68·77	1·837	3·85	83·7	87·5	1·040	0·460	1·108
100	14·108	70·88	1·918	2·828	1·980	69·69	67·71	2·152	4·49	88·4	92·5	1·355	0·556	1·443

vapour of water is nearly constant, the difference of quantity of heat for cooling is not materially changed.

A study of the last two columns will demonstrate that as the quantity of moisture present in air falls off much more rapidly than the temperature, the quantity which is requisite to make up the moisture in air at 70° and 70 per cent humidity, from the condition at the various temperatures with the same ratio of humidity, becomes more and more nearly the same as the temperatures fall off. The great heat demanded for changing water into vapour accordingly, is nearly constant for the low temperatures, and the heat demanded for warming air gains on that for vapourisation of water; and after passing a greatest difference at between 55° and 60°, attaining an equality at about 36°, it becomes about one-half greater at 0°.

The tabular values here given have, it is thought, been first grouped together in this, or any form, and they will be found a ready and convenient basis for the application of the various meteorological conditions to warming and ventilation.

Royal Polytechnic Institution.—Mr. William Stokes is introducing some valuable new suggestions in his Lectures upon the Improvement of the Memory, and is explaining the practical application of his system for teaching the multiplication table by means of easily remembered pictures, the extended table being placed at the ready command of children and accountants by an agreeable and expeditious process.

THE SPIRAL BALANCE.

By C. F. CROSS.

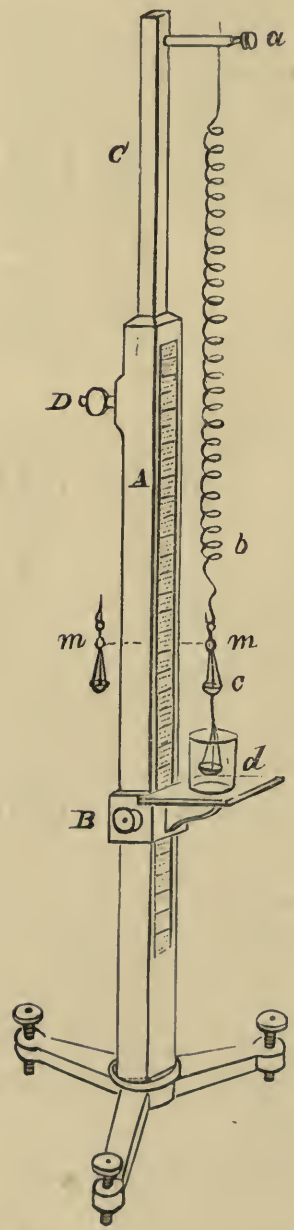
In my researches on the Rehydration of Metallic Oxides and Salts,* I was met by the necessity of frequent and rapid weighings of a substance in an atmosphere saturated with aqueous vapour. Having carefully considered the adaptability of the beam balance to this purpose and found it wanting, or rather perhaps inferior to the balance I am about to describe, my choice fell upon the latter. Jolly's Federwaage or spiral balance boasts of no new principle, but by a refined application of the well-known property of a metal spiral of undergoing elongations when stretched by weights, up to a certain limit, which are in the simple ratio of those weights, has given us an instrument whose advantages should secure its adoption in every laboratory. The balance in its original form is represented in Fig. 1. (*Sitzungsber. Baey. Akad.*, 1864, i., 162).

The spiral is fastened by means of a binding screw at *a*, and carries below, suspended at *b*, two small pans, *c* and *d*, connected as shown in the drawing. Of these, *d*, which is of glass, is kept immersed in water, and serves to steady the whole and bring the spiral, together with the index *m*, rapidly to rest after displacement, and is also used in cases of weighing beneath the surface of a liquid, as in determination of sp. gr.

* *Jour. Chem. Soc.*, 35, 796.

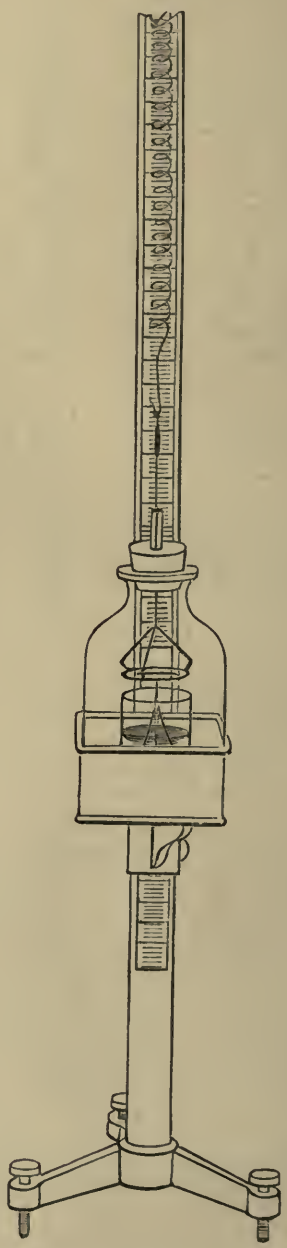
The glass containing the water in which *d* is immersed is supported on a bracket, B, which is movable over the hollow upright, A, and may be fixed at any height by means of a binding screw. C, the rod which carries the spiral, fits loosely into the hollow portion of A, and is of the same length; it can be raised out of A by any portion

FIG. 1.



of its length, and is fixed by means of the binding screw, D. The base of the instrument is a tripod, provided with levelling screws, as shown in the figure. The elongations of the spiral are observed by means of the index, *m*, which is a small bead of opaque white glass, and a mirror scale (millimetre), which is let into one of the sides of A. The position of *m* is read off with accuracy with the naked eye by bringing *m* exactly to cover its image in the mirror, which, occurring upon a graduation or between two, is easily observed to ½ m.m. Previously to making an observation it is necessary to adjust *m* by moving C, either to the zero of the scale or to a point sufficiently high to allow of the elongation to be followed on the scale.

FIG. 2.



The following examples are given by Prof. V. Jolly in his original paper:—

(*a*) *Determination of Absolute Weight.*—The spiral consisted of 36 turns of piano-wire (No. 6).

Original reading of *m*..	2·5
With a load of 1 grm...	374·7
With the object to be weighed..	213·6

The absolute weight of the latter is—

$$\frac{213{\cdot}6-2{\cdot}5}{374{\cdot}7-2{\cdot}5}=0{\cdot}5611 \text{ grm.}$$

with the probable error in the fourth place of decimals.

(β) *Determination of Specific Gravity of a Solid.*—

Original reading of *m*	64·2
Loaded with a crystal placed in pan, *c* ..	275·3
" " " " " *d* ..	220·8

$$\text{Sp. gr.} = \frac{\text{Absolute weight}}{\text{Loss of wt. in water}} = \frac{275{\cdot}3-64{\cdot}2}{275{\cdot}3-220{\cdot}8} = 3{\cdot}85,$$

with the probable error in the second decimal place.

(γ) *Determination of Specific Gravity of a Liquid.*—In this case the lower pan, *d*, is removed and replaced by a small cylinder of glass of about 1 c.c. capacity. The loss of weight experienced on submerging the latter beneath the surfaces of the respective liquids is expressed in scale divisions, as in the preceding instances, and the quotients of such numbers are the relative weights.

Since the publication of the original paper there have been certain modifications of the above details. For the plain spirals of piano-wire, spirals of brass of slightly conical form have been substituted, which although difficult to prepare, are a great improvement upon the old; and in determinations of the sp. gr. of liquids, the scale pan arrangement is altogether removed, and replaced by a simple contrivance, of which the glass cylinder and the index on the suspending wire are the chief features.

I will now give a brief account of the application of the instrument to the work of investigating the phenomenon of rehydration.

It would have been advantageous could I have kept the spirals continuously stretched by the substances under examination, but a series of blank experiments established the fact that the spirals, when stretched by a constant weight, are perpetually undergoing slight elongation. It was necessary, therefore, to adopt the discontinuous method of observation, and even then to be watchful against displacements of the o point, sometimes observable after a long series of weighings, especially in the case of new spirals.

On the strictness of the ratio of elongation to stretching weight and its comparative inalterability, I submit the following observation from amongst many similar: α, with the original spiral (of brass wire, 0·5 m.m. diameter, 111 turns wound conically); β, with the same spiral after two months constant use.

	α.		β.	
Stretching Wt. Grms.	Elongation. M.m.	Per Centigrm. M.m.	Elongation. M.m.	Per Centigrm. M.m.
0·5	46·5	0·93	47	0·93
0·55	51	"		
1·0	92	0·92	93	0·93
1·5	140	0·93	139·5	0·93
1·55	144·5	"		
2·0	186	"	186	0·93
2·5	232	"		
2·55	237	"	231	0·925
3·0	279	"	277·5	0·928
3·5	324·5	"	323·5	0·925
3·55	329·5	"		
4·0	371	"	369·5	0·93
4·5	417	"		
4·55	421·5	"		
5·0	463	"	460·5	0·924

The error, therefore, due to the imperfect elasticity of the spiral, vanishes in respect of an average weighing; that due to change of elasticity as the result of superficial oxidation and molecular change, has also proved so far barely recognisable; that due to change of temperature, as well also as the preceding, is easily controlled by readjustment of the index to zero. This was done, I need scarcely say, before each of the series of observations recorded in the above tables.

In further illustration of the reliability of the instrument I may cite an extended series of observations, ranging over a period of 282 hours, during which time no readjustment took place. This was an investigation of the hydration of potassium bichromate by the method to be presently described, and involved 75 weighings by one and the same spiral. The initial elongation due to the anhydrous salt was 89 m.m. The limit of hydration I observed to be $2K_2Cr_2O_7{\cdot}7H_2O$, and to be attained at the 147th hour of its exposure to the space saturated with aqueous vapour (temp., 18° to 20°). After this point the observations were continued to the 283rd hour, 30 weighings being made; all the readings fell between 107 and 108 m.m., showing the constancy of the hydration and of the spiral. At the 283rd hour the bell jar surrounding the salt was removed, and the result of this exposure to the ordinary air observed. The reading taken after the lapse of 1 hour (temp., 16°) was 93 m.m.; after 2 hours, 90 m.m, *i.e.*, the initial position was virtually regained. This is a typical example of the nature of my researches and the capabilities of the balance.

It only remains for me to describe the modification of the instrument necessitated by my work, and ably carried out by Herr Berberich, the Präparator of München.

The scale pan, *c*, in its original form, I found inconveniently small, and in all respects unsuitable. After several phases of development, the following modification was adopted as altogether satisfactory. A circular mica plate, extremely thin and perfectly smooth, is supported by means of a tri-radial arrangement of thin wire. This carries, below, suspended from the centre, a small disc of thin metal, the substitute for the heavy watch-glass, *d*, of the original, and, above, the index bead, *m*. Both the wire skeleton of the pan and the lower disc have a triple suspension of the finest platinum wire.* The mica plate is easily slipped into and out of the wire support, and supplies a movable scale pan of 70 m.m. diameter, amply large enough, therefore, for the purposes of my research. The whole arrangement, moreover, weighing less than 3 grms., allows some 2 to 3 grms. of substance to be placed under observation without exceeding the limits of elasticity of the spirals. Fig. 2 is a sketch of the apparatus thus modified and adapted to observations of hydration; the spiral is shown connected with the scale pan ready for observation. This completed, it is disconnected, and the terminal wire of the scale pan is placed upon a hook, which is carried below by a thimble-shaped cap; this is then placed upon the glass tube which passes through the cork of the bell-jar, and so the saturated air within is cut off from the outer air. The trough, which is carried by the bracket, is filled to the height of about 1 inch with water, and this completes the sealing of the bell-jar below.

In conclusion I would inform my fellow chemists of yet another advantage of this instrument, viz., its cheapness. In its original form it costs something under 30 shillings, and with the improvements above detailed, together with a supply of wire, &c., for repairs, it can be had, delivered free, for less than £2.†

Revision of Analytical Methods.—The "Central Society of Chemical and Commercial Industries" has nominated a commission for the revision of the analytical processes used in determining the value or the purity of commercial products.—*Moniteur Scientifique.*

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* The construction is so simple that I am able in a few minutes to complete the mounting of the mica plate, the only materials required being copper and platinum wires, tin-foil, and bugle beads of white glass.

† Those who wish to supply themselves with this balance should apply to the maker, Herr K. Berberich, Präparator, K. Universität, München, and, if they require the improved scale pan, to say so. I believe Messrs. Woolley, of Manchester, are about to be entrusted with the agency.

CORRESPONDENCE.

THE HISTORY OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I incline to put before chemists the following idea, and shall be glad if you think it well to assist me by inserting it in the CHEMICAL NEWS. I sent it last year to the British Association Chemical Committee, but Dr. Gilbert, who was then President, tells me that little interest was shown. My interest in the matter is not less, although my time for attention to it is so.—I am, &c.,

R. ANGUS SMITH.

MY DEAR DR. GILBERT,—As you are going to the British Association Meeting at Swansea I am inclined to put before you an idea which has long been in my mind, regarding a method of obtaining for chemists a better knowledge than they now have of the early writings of those who first made attempts to learn something of the qualities of matter at present called chemical, as differing from those usually called physical. We have fine histories of chemistry; we can scarcely wish a better than Kopp's as one, especially if supplemented by Hoefer's; but none of these volumes can give the spirit of these old writers so well as the books of the old writers themselves, whilst the number of the latter is so great that few chemists have time to read them; still many of the volumes are only in a few places attainable, and the languages are such as all chemists cannot be expected to learn, whilst in some cases the difficulty of translation is very great, and perhaps insurmountable in others.

I proposed to the late Prof. Graham that the Cavendish Society should form a small library of chemical history. I forget the exact words which I used; but the Society was not flourishing, and had given up all idea of doing more than finishing the translation of Gmelin's "Chemistry."

My proposal was and is to publish the earliest chemical works; one or two from even the earlier centuries may be found. There will be great disputes as to their value, their meaning, their age, the purity of the text, and so on; but it would be well if they were in the hands of chemists, so that each should judge for himself: one volume will hold many of the less wordy writers, and we need order, arrangement, and modern handling. Again, one part of the plan is to have printed all that obscure portion which is found in Greek manuscripts in various libraries in Europe,—writings which were more attended to by the older chemists, but which have been again brought more into notice in later years, first by Hoefer in France, and afterwards by a fuller account in a separate volume by Prof. Kopp.

At present, however, the knowledge of them is imperfect, and it would require the combined skill of many persons to bring out of them all that seems possible. The text may be obscure, but the allusions may be, and I believe they are, in some cases sufficient to lead us to the origin of the writings, or at least the source from which the writers took some of their ideas. A small expression may connect itself with a philosophy or a religion which may have been acting on the minds of these early thinkers; and a minute study of the language, and the very quality of its corruptions, may reveal much interesting knowledge.

I only hint at these things. I feel inclined to think that chemists will consider a hint quite sufficient, and that the importance of the work will be seen at once.

After these very early writings are printed, and the yet unpublished Greek ones, whether early or otherwise, a good specimen of each succeeding period would be found perhaps enough. The few Greek MSS. which I have seen were in excellent condition, but the various copies might be collated. Some may be more difficult to read.

I have failed to rouse any interest in this subject in the minds of Greek scholars. I have had the pleasure of assisting my friend Dr. Young, F.R.S., to make a collection of chemical and alchemical books printed before the year 1800, but the difficulty of obtaining many of the volumes is very great, and it is constantly increasing. Books which were sold almost as waste paper in my youth are scarcely now to be had to purchase.

But, independently of all this, no one can obtain a clear idea of the writings of the earlier gropers after chemistry without an amount of labour which is equal to the study of a separate science.

Is it not possible to make such a short collection, and to arrange it in such a manner as to enable us to learn more clearly the links of connection with other departments of human thought and history? I believe it is: I should be glad if the British Association felt interested in the subject. Editors would be sought from any country that would supply them; and without asking too much from Prof. Kopp, the great historian of chemistry, we might fairly hope that he would take an interest in the matter; he could of all men best give guidance.

Prof. Graham liked the plan, and wished me to begin; but I had not time, and it is not work for a private man or for one man.

It is true that the subject might be brought before the Chemical Society, but I am inclined to think the British Association better suited. This, however, is a point on which you will give an opinion, and I leave the matter in your hands.—I am, yours sincerely,

(Signed) R. ANGUS SMITH.

Dr. GILBERT, F.R.S.,
Pres. Chem. Sect. Brit. Assoc., Swansea.

PS. It might be well to form a committee to consider, and, if agreeable, to make preliminary arrangements. It might be called the Chemical History Committee.

To this I may add I was desirous of not allowing to die a plan formed many—perhaps twenty-five—years ago. I have never lost sight of it; and my recent enquiries into the origin of the word Chemistry have given me a further proof that the Science has been closely connected with much of the higher—that is, the philosophical and religious—thought of man, as well as with the mysticism of a portion of his history.

It must not be supposed that I expect to find any fact of any value in Chemical Research as encouraged by this Society. The value is one which arises from the assistance which is promised in making clearer to us the origin and progress of thought and of feeling in man. It is a portion of the work to be done in attaining a full history of humanity and the philosophy of man.

I cannot expect merely practical chemists to take an interest in it. I cannot expect even to find an interest in it raised in men whose sole object is to find new chemical compounds. I will even go farther, and say that I cannot expect the merely scientific chemist to interest himself in such matters; but I do expect an interest in those men who look to our Chemistry as a part only of the science with which Philosophy works, using its results as simple tools to gain her ends. I think we shall find among chemists a sufficient breadth of education and of unselfish interest to give great encouragement to the plan. I do not at all doubt this, but there may be a difficulty to find a man fitted to edit the works as they ought to be, one which is capable of finding the fulness or emptiness of the writers. For the Greek manuscripts he would require to familiarise himself for a while with the style of language not merely of the manuscripts, but of the writers of the Greek Empire. He would require to be very well versed in classic knowledge, and the more he knew of Egypt and the East the easier would be his task; but one thing also is essential,—he must not only have read the history of religions and philosophies, but he must have lived in them

sufficiently to have gained full sympathy with certain portions, and good reasons for refusing sympathy with others; he must know something of chemistry.

All these qualities are required in a perfect editor, and many classes of thinkers will be interested in such works; still it is probable that we do enough at first by publishing—perfect editing will be gradual. I cannot doubt that in time help will come in from various quarters, and a united attempt will be made to clear up the still dark portions of the history of the science, and the effects of its study in the mind of the various generations of mystic philosophers, and also artisans, through many ages back to its natural birthplace.

R. A. S.

December, 1880.

THE FRAUDULENT ALTERATION OF CHEQUES.

To the Editor of the Chemical News.

Sir,—On reading the Specification of Messrs. Dupré and Hehner's proposed safety-cheques, it at once occurred to me that they could still be altered by means of a device familiar to colour-mixers. If the cheque is first steeped in cadmium nitrate, and then treated with an acid, there is produced not the black lead sulphide, but the yellow cadmium sulphide. So small is the quantity required that the yellow tone is scarcely perceptible, and can be quite overcome by a slight blue wash. If the forger applies an alkaline solution to remove the ink, he needs merely add a certain quantity of sodium hydrocarbonate, when there will be no change of colour at all.

Even sulphuric acid at a certain strength may be safely applied; the result will be not black lead sulphide, but white lead sulphate.

I have seen these experiments actually exhibited by a chemist of my acquaintance, who assures me that he made a complete trial, three years ago, of this mixture of zinc sulphide and lead carbonate, but abandoned it as inefficient.—I am, &c.,

Calico-Printer.

DISULPHIDE OF CARBON IN COMMERCIAL BENZOL, AND ITS UTILISATION.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliii., p. 148, Mr. Nickels points out a very simple method of removing carbon disulphide from commercial benzols, further suggesting that the plan indicated might be employed on the large scale for a similar purpose. Now as the question of this compound in benzols is continually cropping up and intruding itself as a fertile source of complaint, it might just be worth the while of those interested in the problem to give the matter some little consideration, especially as it is one that might be a means of considerable profit, so far at least as disulphide is concerned.

Assuming the quantity present in ordinary make of "90 per cent" to be 1½ per cent by weight, 1000 gallons would contain 132 lbs. disulphide, and which, converted into potassium xanthate, would furnish 278 lbs. of that substance. This product, now widely known as potassium ethyl-sulpho-carbonate, represents a compound that has been made and used in large quantity for the destruction of the Phylloxera, or "Vine pest," and for other forms of insect life noxious to vegetation. As such its formation and removal from commercial benzols would not only greatly improve their quality, but supply a new source of a highly valuable compound, and which could be separated and utilised at a very handsome profit on the operation.—I am, &c.,

X. X.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 2, July 11, 1881.

Speed of Propagation of Explosive Phenomena in Gases.—M. Berthelot.—The propagation of explosive phenomena appears due to the transmission of successive shocks of the gaseous molecules brought to a more intense vibratory state by the heat liberated in their combination, and transformed at once, or more correctly speaking, after a slight relative displacement. This circumstance assimilates it to the propagation of detonations in solid matters. Consequently the speed of the propagation of explosion in a gas becomes comparable to the speed of sound, which is likewise propagated in virtue of an undulatory movement; the speed of these two movements being of the same order as the speed of the translation of gaseous molecules.

Influence of Phosphoric Acid upon the Phenomena of Vegetation.—M. de Gasparin.—The writer explains that he has been led astray by a mistranslation of the memoir of Prof. Ricciardi.

Attempt at an Explanation of the Tails of Comets.—A. Picart.—Until lately there have been admitted only three states of matter, the solid, the liquid, and the gaseous. Recently there has been added a fourth state, the radiant,—that of a gas so rarefied that each of its molecules, in its movement, according to the dynamic hypothesis of Bernouilli, experiences merely few shocks from other molecules, and describes a trajectory composed of rectilineal elements. These are the states of so-called ponderable matter, obeying the law of gravitation. But there is another matter, imponderable, diffused uniformly in the universe, forming a sort of substratum, in which ponderable matter moves, and which is perhaps the only matter, becoming transformed by the movement, and the varied grouping of its atoms of different forms into the different states of ponderable matter. When this matter is agitated in any point, this point becomes a focus of light, so that if it is in vibration for a certain extent it presents the appearance of a luminous body. It is then, as it were, a new state of matter, which may be called the luminous state, consisting in the vibratory condition of an accumulation, more or less extensive, of the ethereal matter. But the peculiarity of the ether, as of all fluid matter, is that the intermittent repulsion of its atoms produced by the shocks which they impart in their mutual movements, may be ideally expressed as a permanent repulsion between these atoms supposed to be immovable—a repulsion which varies according to a certain function of the distance, decreasing as the latter increases. This new imponderable matter possesses the characteristic property that a repulsive action is exerted between its elements. The author explains certain cosmic phenomena by means of this form of matter.

Absolute Measurement of Currents by Electrolysis.—M. Mascart.—With the number 107·93, given by M. Stas as the atomic weight of silver, and adopting the unities of Weber, the author finds the electro-chemical equivalent of water as 0·009373 milligrm. If, on the contrary, we take the practical units of the British Association, it results that a current, the electro-magnetic intensity of which is represented by 1 weber, decomposes in one second a weight of water = 0·09373 milligrm., or more generally a fraction equal to 0·010415 of the atomic weight of the body expressed in milligrms. The intensity of a current capable of producing in one second the electrolysis of one atom of a body expressed in milligrms. would be equal to 96·01 webers.

Chlorides of Iron.—P. Sabatier.—A thermo-chemical study of the two hydrated ferrous chlorides, $FeCl,2H_2O$ and $FeCl_4H_2O$; of the two hydrated ferric chlorides, $Fe_2Cl_3,5H_2O$ and $Fe_2Cl_312H_2O$; and of the hydrochlorate of ferric chloride.

Strontium and Barium Oxy-chlorides.—M. André.—A thermo-chemical study. The formation-heat of strontium oxy-chloride exceeds that of barium oxy-chloride. Hence strontia has a greater tendency to form an oxy-chloride than baryta. This tendency is still more marked in lime, which forms a more basic oxy-chloride, and with a still more considerable liberation of heat.

Experimental Researches on the Decomposition of Potassium Picrate, and an Analysis of the Products.—MM. Sarrau and Vieille.—The gases yielded by the explosion in the order of their relative quantities are carbonic oxide, nitrogen, carbonic acid, and hydrogen, with smaller quantities of hydrocyanic acid and marsh-gas.

Decipium and Samarium.—M. Delafontaine.—Inserted in full.

Action of Plumbic Peroxide on Alkaline Iodides.—A. Ditte.—Not adapted for abstraction.

Ethers of Morphine considered as a Phenol.—E. Grimaux.—The author refers to his announcement in a former memoir that morphine presents a phenolic character, and furnishes ethers of the same type as does phenol, and to his description of a methylic ether identical with codeine, and an ethylic ether, or codethyline. He has since examined the action of various alcoholic chlorides, bromides, iodides, and analogous bodies, and has discovered that the reaction is general.

Researches on the Tertiary Monamines. Action of Tri-ethylamine on the Hydracid Ethers of the Secondary and Tertiary Alcohols.—E. Reboul.—In this paper the author describes the action of tri-ethylamine upon iso-propyl iodide, and pseudo-propyl bromide.

Cyanised Camphor.—A. Haller.—This compound, in alcoholic solution, is partly resolved into hydrocyanic and camphic acids.

Composition of Sodium Hydrosulphite and Hydrosulphurous Acid.—A. Bernthsen.—The author maintains that the composition of this salt is not expressed by the formula of M. Schützenberger, $NaHSO_2$, but by $NaSO_2$, leaving the constitutional or hydration water out of sight. The anhydrous acid is S_2O_3 and not SO, as M. Schützenberger considers.

Two Facts Concerning Decilene (Essence of Turpentine.—E. J. Maumené.—Sulphuric acid can be mixed in equal weights with this hydrocarbon cooled to 0°, and set in motion in the author's apparatus ("Théorie Générale, p. 5). The mixture may be obtained colourless; if it is allowed to rise to the ordinary temperature there is no speedy action. It must be heated not merely in the water-bath, where there is no action, but in the sand-bath. After two or three hours scarcely a few grains can be collected; the rest forms a black mass, a product of polymerisation. All the results are foreseen by the author's theory. The action of mercuric chloride gives also results predicted by theory. The mixture may be heated up to 180°. If distilled in alcohol, or in a mixture of ether and alcohol, the vapours carry along with them a notable quantity of a compound, which, if introduced into the pulmonary organs would occasion incurable poisoning.

Viscose, the Gummy Substance of Viscous Fermentation.—A. Béchamp.—Viscose is a white substance, easily powdered, and has not at all the appearance of gum. It dissolves in cold water, rendering it glutinous, like gum. It does not reduce the cupro-potassic reagent. Alcohol precipitates it entirely from its solution as a mass which can be drawn into threads. Its elementary composition is: carbon, 44·97; hydrogen, 6·26. The solutions of viscose are not coloured blue or violet by iodine. Viscose yields two nitro-derivatives which are characteristic. Sulphuric acid acts upon viscose as a starch, forming dextrins and a glucose. The dextrins do not ferment under the influence of beer yeast.

Determination of Urea by means of Standard Sodium Hypobromite.—M. Quinquand.—When sodium hypobromite reacts upon urea the latter is decomposed into nitrogen and carbonic acid. Three molecules of hypobromite are necessary for the decomposition of 1 mol. of urea. Hence it is sufficient to determine the hypobromite used in order to know the quantity of urea decomposed. To determine the hypobromite we make use of an alkaline decinormal solution of sodium arsenite. On adding to such a solution a drop of sulphate of indigo, the latter takes a yellowish green colouration. On running in the hypobromite the colour decreases in intensity, and when the point of saturation is reached, it disappears entirely. The reaction may be rendered more sensitive by adding another drop of indigo before reaching the end of the reaction. To determine hypobromite used in the decomposition of the urea it is dropped into the latter till there is no longer any escape of gas; a small excess of hypobromite is added, and a small excess of a known quantity of standard sodium arsenite, an excess denoted by the decolouration of the liquid, and verified by adding one or two more drops of sulphate of indigo, which should remain yellow. Hypobromite is then again added until the indigo is decolourised; if from the total quantity of the hypobromite used we deduct the arsenite added in excess, and expressed as hypobromite, we have the quantity of hypobromite which has reacted upon the urea and consequently the latter. By repeated experiments we have demonstrated that a solution of hypobromite made in any manner does not give the theoretic figure $3NaBrO$. The solutions which give the theoretic figure are: water, 28 c.c.; soda-lye 100 c.c.; bromine, 2·8 c.c.; or soda-lye, 100; bromine, 3 c.c.

Chemical Researches on the Secretion of the Ink Pouch in the Cephalopods.—P. Girod.—The black matter purified by successive digestions in alcohol, ether, glacial acetic acid, sodium carbonate, to which a little potassa has been added, and dilute hydrochloric acid gave on ultimate analysis:—Carbon, 53·6; hydrogen, 4·04; nitrogen, 8·8, the remainder being oxygen.

Annales de la Société des Sciences Industrielles de Lyon. No. 4, 1881.

This publication persistently avoids those branches of chemical technology which are chiefly connected with the trade of Lyon. The only matter at all connected with chemistry is an anonymous report on experiments with chemical manures. The "complete manure" of M. Ville seems to have given the best results.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. May, 1881.

Report Presented by M. Vincent on Behalf of the Committee of Chemical Arts, on a Communication from the French Celluloid Company.—In this report it is admitted that celluloid must be preserved from any notable elevation of temperature, even momentary, in order to avoid serious accidents. It ought only to be stored up in limited quantity. Cold mineral acids only attack it slightly, but it is quickly destroyed by nitric and sulphuric acids if hot. It is quickly dissolved, even in the cold, in a mixture of alcohol and ether. The nitro-cellulose, which is the basis of this product, is prepared from cigarette paper.

Report Presented by M. Schützenberger on Behalf of the Committee of the Chemical Arts, on a Method Proposed by M. Maistrasse for Detecting the Impurity of Tin Used in the Manufacture of Tin Plate.—The process of M. Maistrasse is based on the difference of

aspect of the *moiré metallique*, obtained on metallic surfaces according to the degree of impurity of the tin. The only manipulation required is washing the surface with dilute hydrochloric acid, either pure or mixed with nitric acid. If lead is present in a quantity exceeding 5 per cent the appearance of the *moiré* is distinctly altered.

Journal für Praktische Chemie.
No. 7, 1881.

My Share in the Development of Theoretical Chemistry.—H. Kolbe.—The first part of a historical survey, characterised by equal ability and severity. To give any detached portions of a discussion entering so largely into personal considerations would lay us open to the charge of unfairness.

The Compounds of Certain Solid Dioxide Hydrates with Acids, Salts, and Alkalies.—J. M. van Bemmelen.—The author considers, after a series of experiments on the action of amorphous hydroxides upon solutions of salts, acids, and alkalies, that most of these phenomena can be reckoned among the formative processes of feeble chemical combinations which are in a state of dissociation, and that they depend upon chemical laws. He was first led to these researches by the results of an earlier investigation on the absorptive power of arable soil, and of silicic acid as regards solutions of alkalies and alkaline salts.

Preparation of Sulphuryl-chloride.—H. Schulze.—A preliminary communication. The author has observed that a liquid mixture of camphor and sulphurous acid yields sulphuryl-chloride on treatment with free chlorine.

Reply to a "Monitum."—F. Beilstein.—The author gives an explanation of his seeming omission of Professor Kolbe's researches in his recent work on organic chemistry.

Le Génie Civil. No. 11, April 1, 1881.

Extraction of the Precious Metals by Electro-Chemical Amalgamation.—An account of the Designolle process. The treatment of the ores consists of eight successive processes:—Fracture, grinding, suspension in water, trituration to a pulp, electro-chemical amalgamation, the filtration of the amalgam, its concentration and distillation, and lastly, the fusion of the precious metal obtained. Each of these operations is described at length and with reference to illustrations.

Moniteur Scientifique, Quesneville.
May, 1881.

Points of Contact between Art and Science in the Manufactures of Earthenware and Porcelain.—Prof. A. H. Church.—A translation of lectures delivered before the Society of Arts.

Cinchonidine and Hæmo-cinchonidine.—Dr. O. Hesse.

Cinchonine.—Dr. O. Hesse.

Determination of Cinchonidine Sulphate in Quinine Sulphate.—Dr. O. Hesse.—These three memoirs are taken from *Liebig's Annalen*.

The Question of the Rosanilines.—J. A. Pabst.—The author criticises the present theoretical views on the formation and constitution of the rosanilines, especially the views put forward by MM. Fischer. He holds that rosaniline may be a secondary triamine, possessing a hydrozoic or di-imidic structure. If leucaniline is derived from triphenyl-methan the transformation is effected by a simple molecular transposition.

Cotton-seed Oil.—M. Wideman.—Cotton-seed oil at 0° has the sp. gr. 0·9406; at 30° it is only 0·9206. With oil of vitriol it takes a violet tint, which increases on stirring. At the end of twenty-four hours the mixture becomes thick and deep brown. With sulphuric acid and potassium bichromate there is a violent reaction; sulphurous acid is evolved, and the oil takes a blood-red colour. At the end of twenty-four hours it has become a black solid mass. With caustic alkalies (sp. gr. 1·24) the oil thickens, becomes a straw-yellow, while the alkaline solution separates, and takes a deeper colour. If the mixture is stirred with a glass rod the upper layers take a blue colour, which gradually passes into a violet.

Industrial Society of Mulhouse.—Session of March 9, 1881.—MM. Pfeiffer and Jugenohl gave a description of a machine for printing several colours, upon a quite new system.

M. Benner proposes to print aniline-black along with dyed alizarin violets without fear of running or spreading. He adds to the violet mordant a large excess of acetate of lime.

Alkalimetric Determination of Sulphate of Soda in Crude Salt-cake.—Armand Bertrand.—The author dissolves 1 grm. of the sample in hot water, precipitates with an excess of baryta water, lets cool, and filters. He passes an excess of carbonic acid into the filtrate, heats to a boil, and lets cool; filters, and in the filtrate he determines the carbonate of soda (corresponding to the original sulphate of soda) with normal sulphuric acid.

Determination of Nitrates.—A. Bertrand.—The author modifies Bolley's process by determining the chlorides and deducting from the total carbonates the quantity formed by the decomposition of the chlorides.

Iodal.—A. Bertrand.—The author has obtained this compound by passing hydriodic acid into anhydrous chloral or bromal.

June, 1881.

New Mechanical Furnace for the Continuous Manufacture of Salt-cake.—James Mactear.—From the *Journal of the Society of Arts*.

Review of Chemical Researches Published in Germany.—A series of extracts from the *Berichte der Deutsch. Chem. Gesellschaft*.

Water and Air.—Lectures delivered by Dr. J. Tyndall.—A reprint from the *Journal of Science*.

Salicylic Acid.—E. Robinet.—Strictures on the report by Dr. Dubrisay, drawn up in the name of the Consulting Committee of Hygiene.

Notes by M. E. Maumené.—A reply to the criticisms of Spencer Pickering, and two notes on the action of nitric acid upon metals, and on the decomposition of mercury and silver cyanide, both already noticed.

Industrial Society of Mulhouse.—Session of the Chemical Committee, April 6th.—Certain prizes were announced, but no new results in the tinctorial arts were brought forward.

Creosote.—A. Kopp.—Not adapted for abstraction.

July, 1881.

Determination of Urea by Means of a Standard Solution of Sodium Hypobromite.—A memoir extending over upwards of thirty pages, and not capable of useful reproduction without the illustrations and the accompanying tables.

Vaccination for "Charbon."—In the course of a discussion which took place at the meeting of the Academy of Medicine, June 14, M. Pasteur announced that the operation had been performed on apes with very satisfactory results. The discussion had its usually warm character.

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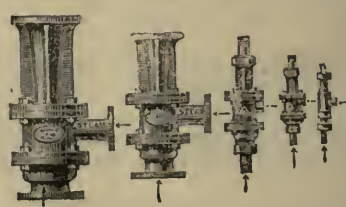

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1136.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

York Meeting, August 31, 1881.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., Pres. Linn. Soc.

In the name of the British Association, which for the time I very unworthily represent, I beg to tender to you, my Lord Mayor, and through you to the City of York, our cordial thanks for your hospitable invitation and hearty welcome.

We feel, indeed, that in coming to York we are coming home: gratefully as we acknowledge and much as we appreciate the kindness we have experienced elsewhere, and the friendly relations which exist between this Association and most—I might even say all—our great cities, yet Sir R. Murchison truly observed at the close of our first meeting in 1831, that to York, "as the cradle of the Association, we shall ever look back with gratitude; and whether we meet hereafter on the banks of the Isis, the Cam, or the Forth, to this spot we shall still fondly revert." Indeed, it would have been a matter of much regret to all of us if we had not been able on this, our fiftieth anniversary, to hold our meeting in our mother city.

My Lord Mayor, before going further, I must express my regret, especially when I call to mind the illustrious men who have preceded me in this chair, that it has not fallen to one of my eminent friends around me to preside on this auspicious occasion. Conscious, however, as I am of my own deficiencies, I feel that I must not waste time in dwelling on them, more especially as in doing so I should but give them greater prominence. I will, therefore, only make one earnest appeal to your kind indulgence.

The connection of the British Association with the City of York does not depend merely on the fact that our first meeting was held here. It originated in a letter addressed by Sir D. Brewster to Professor Phillips, as Secretary to your York Philosophical Society, by whom the idea was warmly taken up. The first meeting was held on September 26, 1831, the chair being taken by Lord Milton, who delivered an address.

Of those who organised and took part in that first meeting few, alas! remain. Brewster and Phillips, Harcourt and Lord Milton, Lyell and Murchison, all have passed away, but their memories live among us. Some few, indeed, of those present at our first meeting we rejoice to see here to-day, including one of the five members constituting the original organising Committee, our venerable Vice-President, Archdeacon Creyke.

The constitution and objects of the Association were so ably described by Mr. Spottiswoode, at Dublin, and are so well known to you, that I will not dwell on them this evening. The excellent President of the Royal Society, in the same address, suggested that the past history of the Association would form an appropriate theme for the present meeting. The history of the Association, however, is really the history of science, and I long shrunk from the attempt to give even a panoramic survey of a subject so vast and so difficult; nor should I have ventured to make any such attempt, but that I knew I could rely on the assistance of friends in every department of science.

Certainly, however, this is an opportunity on which it may be well for us to consider what have been the principal scientific results of the last half century, dwelling especially on those with which this Association is more directly concerned, either as being the work of our own members, or as having been made known at our meetings. It is of course impossible within the limits of a single address to do more than allude to a few of these, and that very briefly. In dealing with so large a subject I first hoped that I might take our annual volumes as a text-book. This, however, I at once found to be quite impossible. For instance, the first volume commences with a Report on Astronomy by Sir G. Airy: I may be pardoned, I trust, for expressing my pleasure at finding that the second was one by my father, on the Tides, prepared like the preceding at the request of the Council; then comes one on Meteorology by Forbes, Radiant Heat by Baden Powell, Optics by Brewster, Mineralogy by Whewell, and so on. My best course will therefore be to take our different Sections one by one, and endeavour to bring before you a few of the principal results which have been obtained in each department.

The Biological Section is that with which I have been most intimately associated, and with which it is, perhaps, natural that I should begin.

Fifty years ago it was the general opinion that animals and plants came into existence just as we now see them. We took pleasure in their beauty; their adaptation to their habits and mode of life in many cases could not be overlooked or misunderstood. Nevertheless, the book of Nature was like some richly illuminated missal, written in an unknown tongue; the graceful forms of the letters, the beauty of the colouring, excited our wonder and admiration; but of the true meaning little was known to us; indeed, we scarcely realised that there was any meaning to decipher. Now glimpses of the truth are gradually revealing themselves; we perceive that there is a reason—and in many cases we know what that reason is—for every difference in form, in size, and in colour; for every bone and every feather, almost for every hair. Moreover, each problem which is solved opens out vistas, as it were, of others perhaps even more interesting. With this great change the name of our illustrious countryman, Darwin, is intimately associated, and the year 1859 will always be memorable in science as having produced his great work on the "Origin of Species." In the previous year he and Wallace had published short papers, in which they clearly state the theory of natural selection, at which they had simultaneously and independently arrived. We cannot wonder that Darwin's views should have at first excited great opposition. Nevertheless from the first they met with powerful support, especially, in this country, from Hooker, Huxley, and Herbert Spencer. The theory is based on four axioms:—

"1. That no two animals or plants in nature are identical in all respects.

"2. That the offspring tend to inherit the peculiarities of their parents.

"3. That of those which come into existence, only a small number reach maturity.

"4. That those which are, on the whole, best adapted to the circumstances in which they are placed are most likely to leave descendants."

Darwin commenced his work by discussing the causes and extent of variability in animals, and the origin of domestic varieties: he showed the impossibility of distinguishing between varieties and species, and pointed out the wide differences which man has produced in some cases—as, for instance, in our domestic pigeons, all unquestionably descended from a common stock. He dwelt on the struggle for existence (which has since become a household world), and which, inevitably resulting in the survival of the fittest, tends gradually to adapt any race of animals to the conditions in which it occurs.

While thus, however, showing the great importance of natural selection, he attributed it to no exclusive influence,

but fully admitted that other causes—the use and disuse of organs, sexual selection, &c.—had to be taken into consideration. Passing on to the difficulties of his theory, he accounted for the absence of intermediate varieties between species, to a great extent, by the imperfection of the geological record.

But if the geological record be imperfect, it is still very instructive. The further palæontology has progressed the more it has tended to fill up the gaps between existing groups and species, while the careful study of living forms has brought into prominence the variations dependent on food, climate, habitat, and other conditions, and shown that many species long supposed to be absolutely distinct are so closely linked together by intermediate forms that it is difficult to draw a satisfactory line between them.

The principles of classification point also in the same direction, and are based more and more on the theory of descent. Biologists endeavour to arrange animals on what is called the "natural" system. No one now places whales among fish, bats among birds, or shrews with mice, notwithstanding their external similarity; and Darwin maintained that "community of descent was the hidden bond which naturalists had been unconsciously seeking." How else, indeed, can we explain the fact that the framework of bones is so similar in the arm of a man, the wing of a bat, the fore-leg of a horse, and the fin of a porpoise —that the neck of a giraffe and that of an elephant contain the same number of vertebræ?

Strong evidence is, moreover, afforded by embryology; by the presence of rudimentary organs and transient characters, as, for instance, the existence in the calf of certain teeth which never cut the gums, the shrivelled and useless wings of some beetles, the presence of a series of arteries in the embryos of the higher Vertebrata exactly similar to those which supply the gills in fishes, even the spots on the young blackbird, the stripes on the lion's cub; these, and innumerable other facts of the same character, appear to be incompatible with the idea that each species was specially and independently created: and to prove, on the contrary, that the embryonic stages of species show us more or less clearly the structure of their ancestors.

Darwin's views, however, are still much misunderstood. I believe there are thousands who consider that according to his theory a sheep might turn into a cow, or a zebra into a horse. No one would more confidently withstand any such hypothesis, his view being, of course, not that the one could be changed into the other, but that both are descended from one common ancestor.

No one, at any rate, will question the immense impulse which Darwin has given to the study of natural history, the number of new views he has opened up, and the additional interest which he has aroused in, and contributed to, Biology. When we were young we knew that the leopard had spots, the tiger was striped, and the lion tawny; but why this was so it did not occur to us to ask; and if we had asked no one would have answered. Now we see at a glance that the stripes of the tiger have reference to its life among jungle-grasses; the lion is sandy, like the desert; while the markings of the leopard resemble spots of sunshine glancing through the leaves.

The science of embryology may almost be said to have been created in the last half century. Fifty years ago it was a very general opinion that animals which are unlike when mature were dissimilar from the beginning. It is to Von Baer, the discoverer of the mammalian ovum, that we owe the great generalisation that the development of the egg is in the main a progress from the general to the special,—in fact, that embryology is the key to the laws of animal development.

Thus the young of existing species resemble in many cases the mature forms which flourished in ancient times. Huxley has traced up the genealogy of the horse to the Miocene Anchitherium. In the same way Gaudry has called attention to the fact that just as the individual stag gradually acquires more and more complex antlers: having at first only a single prong, in the next year two points, in the following three, and so on; so the genus, as a whole, in Middle Miocene times, had two pronged horns; in the Upper Miocene, three; and that it is not till the Upper Pliocene that we find any species with the magnificent antlers of our modern deer. It seems to be now generally admitted that birds have come down to us through the Dinosaurians, and, as Huxley has shown, the profound break once supposed to exist between birds and reptiles has been bridged over by the discovery of reptilian birds and bird-like reptiles; so that, in fact, birds are modified reptiles. Again, the remarkable genus Peripatus, so well studied by Moseley, tends to connect the annulose and articulate types.

Again, the structural resemblances between Amphioxus and the Ascidians had been pointed out by Goodsir; and Kowalevsky in 1866 showed that these were not mere analogies, but indicated a real affinity. These observations, in the words of Allen Thomson, "have produced a change little short of revolutionary in embryological and zoological views, leading as they do to the support of the hypothesis that the Ascidian is an earlier stage in the phylogenetic history of the mammal and other vertebrates."

The larval forms which occur in so many groups, and of which the Insects afford us the most familiar examples, are, in the words of Quatrefages, embryos, which lead an independent life. In such cases as these external conditions act upon the larvæ as they do upon the mature form; hence we have two classes of changes, adaptional or adaptive, and developmental. These and many other facts must be taken into consideration; nevertheless naturalists are now generally agreed that embryological characters are of high value as guides in classification, and it may, I think, be regarded as well established that, just as the contents and sequence of rocks teach us the past history of the earth, so is the gradual development of the species indicated by the structure of the embryo and its developmental changes.

When the supporters of Darwin are told that his theory is incredible, they may fairly ask why it is impossible that a species in the course of hundreds of thousands of years should have passed through changes which occupy only a few day or weeks in the life history of each individual?

The phenomena of yolk-segmentation, first observed by Prevost and Dumas, are now known to be in some form or other invariably the precursors of embryonic development; while they reproduce, as the first stages in the formation of the higher animals, the main and essential features in the life-history of the lowest forms. The "blastoderm," as it is called, or first germ of embryo in the egg, divides itself into two layers, corresponding, as Huxley has shown, to the two layers into which the body of the Cœlenterata may be divided. Not only so, but most embyros at an early stage of development have the form of a cup, the walls of which are formed by the two layers of the blastoderm. Kowalevsky was the first to show the prevalence of this embryonic form, and subsequently Lankester and Hæckel put forward the hypothesis that it was the embryonic repetition of an ancestral type, from which all the higher forms are descended. The cavity of the cup is supposed to be the stomach of this simple organism, and the opening of the cup the mouth. The inner layer of the wall of the cup constitutes the digestive membrane, and the outer the skin. To this form Hæckel gave the name Gastræa. It is, perhaps, doubtful whether the theory of Lankester and Hæckel can be accepted in precisely the form they propounded it; but it has had an important influence on the progress of embryology. I cannot quit the science of embryology without alluding to the very admirable work on "Comparative Embryology" by our new General Secretary, Mr. Balfour, and also the "Elements of Embryology" which he had previously published in conjunction with Dr. M. Foster.

In 1842, Steenstrup published his celebrated work on the "Alternation of Generations," in which he showed that many species are represented by two perfectly distinct types or broods, differing in form, structure, and

habits; that in one of them males are entirely wanting, and that the reproduction is effected by fission, or by buds, which, however, are in some cases structurally indistinguishable from eggs. Steenstrup's illustrations were mainly taken from marine or parasitic species, of very great interest, but not generally familiar, excepting to naturalists. It has since been shown that the common Cynips or Gallfly is also a case in point. It had long been known that in some genera belonging to this group, males are entirely wanting, and it has now been shown by Bassett, and more thoroughly by Adler, that some of these species are double-brooded; the two broods having been considered as distinct genera.

Thus an insect known as *Neuroterus lenticularis*, of which females only occur, produces the familiar oak-spangles so common on the under sides of oak leaves, from which emerge, not *Neuroterus lenticularis*, but an insect hitherto considered as a distinct species, belonging even to a different genus, *Spathegaster baccarum*. In *Spathegaster* both sexes occur; they produce the currant-like galls found on oaks, and from these galls *Neuroterus* is again developed. So, also, the King Charles oak apples produce a species known as *Teras terminalis*, which descends to the ground, and makes small galls on the roots of the oak. From these emerge an insect known as *Biorhiza aptera*, which again gives rise to the common oak apple.

It might seem that such enquiries as these could hardly have any practical bearing. Yet it is not improbable that they may lead to very important results. For instance, it would appear that the fluke which produces the rot in sheep, passes one phase of its existence in the black slug, and we are not without hopes that the researches, in which our lamented friend Prof. Rolleston was engaged at the time of his death, which we all so much deplore, will lead, if not to the extirpation, at any rate to the diminution, of a pest from which our farmers have so grievously suffered.

It was in the year 1839 that Schwann and Schleiden demonstrated the intimate relation in which animals and plants stand to each other, by showing the identity of the laws of development of the elementary parts in the two kingdoms of organic nature.

As regards descriptive biology, by far the greater number of species now recorded have been named and described within the last half century.

Dr. Günther has been good enough to make a calculation for me. The numbers, of course, are only approximate, but it appears that while the total number of animals described up to 1831 was not more than 70,000, the number now is at least 320,000.

Lastly, to show how large a field still remains for exploration, I may add that Mr. Waterhouse estimates that the British Museum alone contains not fewer than 12,000 species of insects which have not yet been described, while our collections do not probably contain anything like one-half of those actually in existence. Further than this, the anatomy and habits even of those which have been described offer an inexhaustible field for research, and it is not going too far to say that there is not a single species which would not amply repay the devotion of a lifetime.

One remarkable feature in the modern progress of biological science has been the application of improved methods of observation and experiment; and the employment in physiological research of the exact measurements employed by the experimental physicist. Our microscopes have been greatly improved. The use of chemical reagents in microscopical investigations has proved most instructive, and another very important method of investigation has been the power of obtaining very thin slices by imbedding the object to be examined in paraffin or some other soft substance. In this manner we can now obtain, say, fifty separate sections of the egg of a beetle, or the brain of a bee.

At the close of the last century, Sprengel published a most suggestive work on flowers, in which he pointed out the curious relation existing between these and insects, and showed that the latter carry the pollen from flower to flower. His observations, however, attracted little notice until Darwin called attention to the subject in 1862. It had long been known that the cowslip and primrose exist under two forms, about equally numerous, and differing from one another in the arrangements of their stamens and pistils; the one form having the stamens on the summit of the flower and the stigma half-way down; while in the other the relative positions are reversed, the stigma being at the summit of the tube and the stamens half-way down. This difference had, however, been regarded as a case of mere variability; but Darwin showed it to be a beautiful provision, the result of which is that insects fertilise each flower with pollen brought from a different plant; and he proved that flowers fertilised with pollen from the other form yield more seed than if fertilised with pollen of the same form, even if taken from a different plant.

Attention having been thus directed to the question an astonishing variety of most beautiful contrivances have been observed and described by many botanists, especially Hooker, Axel, Delpino, Hildebrand, Bennett, Fritz Müller, and, above all, Hermann Müller, and Darwin himself. The general result is that to insects, and especially to bees, we owe the beauty of our gardens, the sweetness of our fields. To their beneficent, though unconscious action, flowers owe their scent and colour, their honey—nay, in many cases, even their form. Their present shape and varied arrangements, their brilliant colours, their honey, and their sweet scent are all due to the selection exercised by insects.

In these cases the relation between plants and insects is one of mutual advantage. In many species, however, plants present us with complex arrangements adapted to protect them from insects; such, for instance, are in many cases the resinous glands which render leaves unpalatable; the thickets of hairs and other precautions which prevent flowers from being robbed of their honey by ants. Again, more than a century ago, our countryman, Ellis, described an American plant, Dionæa, in which the leaves are somewhat concave, with long lateral spines and a joint in the middle; close up with a jerk, like a rat-trap, the moment any unwary insect alights on them. The plant, in fact, actually captures and devours insects. This observation also remained as an isolated fact until within the last few years, when Darwin, Hooker, and others have shown that many other species have curious and very varied contrivances for supplying themselves with animal food.

Some of the most fascinating branches of botany—morphology, histology, and physiology—scarcely existed before 1830. In the two former branches the discoveries of von Mohl are pre-eminent. He first observed cell-division in 1835, and detected the presence of starch in chlorophyll-corpuscles in 1837, while he first described protoplasm, now so familiar to us, at least by name, in 1846. In the same year Amici discovered the existence of the embryonic vesicle in the embryo sac, which develops into the embryo when fertilised by the entrance of the pollen tube into the micropyle. The existence of sexual reproduction in the lower plants was doubtful, or at least doubted by some eminent authorities, as recently as 1853, when the actual process of fertilisation in the common bladderwrack of our shores was observed by Thuret, while the reproduction of the larger fungi was first worked out by De Bary in 1863.

As regards lichens, Schwendener proposed, in 1869, the startling theory, now however accepted by some of the highest authorities, that lichens are not autonomous organisms, but commensal associations of a fungus parasitic on an alga. With reference to the higher Cryptogams it is hardly too much to say that the whole of our exact knowledge of their life-history has been obtained during the last half-century. Thus, in the case of ferns the male organs, or antheridia, were first discovered by Nägeli in 1844, and the archegonia, or female organs, by Suminski

in 1848. The early stages in the development of mosses were worked out by Valentine in 1833. Lastly, the principle of Alternation of Generations in plants was discovered by Hofmeister. This eminent naturalist also, in 1851-4, pointed out the homologies of the reproductive processes in mosses, vascular cryptogams, gymnosperms, and angiosperms.

Nothing could have appeared less likely than that researches into the theory of spontaneous generation should have led to practical improvements in medical science. Yet such has been the case. Only a few years ago Bacteria seemed mere scientific curiosities. It had long been known that an infusion—say, of hay—would, if exposed to the atmosphere, be found, after a certain time, to teem with living forms. Even those few who still believe that life would be spontaneously generated in such an infusion, will admit that these minute organisms are, if not entirely, yet mainly, derived from germs floating in our atmosphere; and if precautions are taken to exclude such germs, as in the careful experiments especially of Pasteur, Tyndall, and Roberts, everyone will grant that in ninety-nine cases out of a hundred no such development of life will take place.

These facts have led to most important results in Surgery. One reason why compound fractures are so dangerous, is because, the skin being broken, the air obtains access to the wound, bringing with it innumerable germs, which too often set up putrefying action. Lister first made a practical application of these observations. He set himself to find some substance capable of killing the germs without being itself too potent a caustic, and he found that dilute carbolic acid fulfilled these conditions. This discovery has enabled many operations to be performed which would previously have been almost hopeless.

The same idea seems destined to prove as useful in Medicine as in Surgery. There is great reason to suppose that many diseases, especially those of a zymotic character, have their origin in the germs of special organisms. We know that fevers run a certain definite course. The parasitic organisms are at first few, but gradually multiply at the expense of the patient, and then die out again. Indeed, it seems to be thoroughly established that many diseases are due to the excessive multiplication of microscopic organisms, and we are not without hope that means will be discovered by which, without injury to the patient, these terrible, though minute, enemies may be destroyed, and the disease thus stayed. The interesting researches of Burdon Sanderson, Greenfield, Koch, Pasteur, Toussaint, and others, seem to justify the hope that we may be able to modify these and other germs, and then by appropriate inoculation to protect ourselves against fever and other acute diseases.

The history of Anæsthetics is a most remarkable illustration how long we may be on the very verge of a most important discovery. Ether, which, as we all know, produces perfect insensibility to pain, was discovered as long ago as 1540. The anæsthetic property of nitrous oxide, now so extensively used, was observed in 1800 by Sir H. Davy, who actually experimented on himself, and had one of his teeth painlessly extracted when under its influence. He even suggests that "as nitrous oxide gas seems capable of destroying pain, it could probably be used with advantage in surgical operations." Nay, this property of nitrous oxide was habitually explained and illustrated in the chemical lectures given in hospitals, and yet for fifty years the gas was never used in actual operations.

Few branches of science have made more rapid progress in the last half-century than that which deals with the ancient condition of man. When our Association was founded it was generally considered that the human race suddenly appeared on the scene, about 6000 years ago, after the disappearance of the extinct mammalia, and when Europe, both as regards physical conditions and the other animals by which it was inhabited, was pretty much in the same condition as in the period covered by Greek and Roman history. Since then the persevering researches of Layard, Rawlinson, Botta, and others have made known to us, not only the statutes and palaces of the ancient Assyrian monarchs, but even their libraries; the cuneiform characters have been deciphered, and we can not only see, but read in the British Museum, the actual contemporary records, on burnt clay cylinders, of the events recorded in the historical books of the Old Testament and in the pages of Herodotus. The researches in Egypt also seem to have satisfactorily established the fact that the pyramids themselves are at least 6000 years old, while it is obvious that the Assyrian and Egyptian monarchies cannot suddenly have attained to the wealth and power, the state of social organisation, and progress in the arts, of which we have before us, preserved by the sand of the desert from the ravages of man, such wonderful proofs.

In Europe, the writings of the earliest historians and poets indicated that, before iron came into general use, there was a time when bronze was the ordinary material of weapons, axes, and other cutting implements, and though it seemed *à priori* improbable that a compound of copper and tin should have preceded the simple metal iron, nevertheless the researches of archæologists have shown that there really was in Europe a "Bronze Age," which at the dawn of history was just giving way to that of "Iron."

The contents of ancient graves, buried in many cases so that their owner might carry some at least of his wealth with him to the world of spirits, have proved very instructive. More especially the results obtained by Nilsson in Scandinavia, by Hoare and Borlase, Bateman and Greenwell, in our own country, and the contents of the rich cemetery at Hallstadt, left no room for doubt as to the existence of a Bronze Age; but we get a completer idea of the condition of Man at this period from the Swiss lake-villages, first made known to us by Keller, and subsequently studied by Morlot, Troyon, Desor, Rütimeyer, Heer, and other Swiss archæologists. Along the shallow edges of the Swiss lakes there flourished, once upon a time, many populous villages or towns, built on platforms supported by piles, exactly as many Malayan villages are now. Under these circumstances innumerable objects were one by one dropped into the water; sometimes whole villages were burnt, and their contents submerged; and thus we have been able to recover, from the waters of oblivion in which they had rested for more than 2000 years, not only the arms and tools of this ancient people, the bones of their animals, their pottery and their ornaments, but the stuffs they wore, the grain they had stored up for future use, even fruits and cakes of bread.

But this bronze-using people were not the earliest occupants of Europe. The contents of ancient tombs give evidence of a time when metal was unknown. This also was confirmed by the evidence then unexpectedly received from the Swiss lakes. By the side of the bronze-age villages were others, not less extensive, in which, while implements of stone and bone were discovered literally by thousands, not a trace of metal was met with. The shell-mounds or refuse-heaps accumulated by the ancient fishermen along the shores of Denmark, fully confirmed the existence of a "Stone Age."

No bones of the reindeer, no fragment of any of the extinct mammalia have been found in any of the Swiss lake villages or in any of the thousands of tumuli which have been opened in our own country or in Central and Southern Europe. Yet the contents of caves and of river-gravels afford abundant evidence that there was a time when the mammoth and rhinoceros, the musk-ox and reindeer, the cave lion and hyena, the great bear and the gigantic Irish elk wandered in our woods and valleys, and the hippopotamus floated in our rivers; when England and France were united, and the Thames and the Rhine had a common estuary. This was long supposed to be before the advent of man. At length, however, the discoveries of Boucher de Perthes in the valley of the Somme,

supported as they are by the researches of many Continental naturalists, and in our own country of MacEnery and Godwin-Austen, Prestwich and Lyell, Vivian and Pengelly, Christy, Evans, and many more, have proved that man formed a humble part of this strange assembly.

Nay, even at this early period there were at least two distinct races of men in Europe; one of them—as Boyd Dawkins has pointed out—closely resembling the modern Esquimaux in form, in his weapons and implements, probably in his clothing, as well as in so many of the animals with which he was associated.

At this stage Man appears to have been ignorant of pottery, to have had no knowledge of agriculture, no domestic animals, except perhaps the dog. His weapons were the axe, the spear, and the javelin; I do not believe he knew the use of the bow, though he was probably acquainted with the lance. He was, of course, ignorant of metal, and his stone implements, though skilfully formed, were of quite different shapes from those of the second Stone Age, and were never ground. This earlier Stone period, when man co-existed with these extinct mammalia, is known as the Palæolithic, or Early Stone Age, in opposition to the Neolithic, or Newer Stone Age.

The remains of the mammalia which co-existed with man in pre-historic times have been most carefully studied by Owen, Lartet, Rütimeyer, Falconer, Busk, Boyd-Dawkins, and others. The presence of the mammoth, the reindeer, and especially of the musk-ox, indicates a severe, not to say an arctic, climate, the existence of which, moreover, was proved by other considerations; while, on the contrary, the hippopotamus requires considerable warmth. How, then, is this association to be explained?

While the climate of the globe is, no doubt, much affected by geographical conditions, the cold of the glacial period was, I believe, mainly due to the excentricity of the earth's orbit, combined with the obliquity of the ecliptic. The result of the latter condition is a period of 21,000 years, during one-half of which the northern hemisphere is warmer than the southern, while during the other 10,500 years the reverse is the case. At present we are in the former phase, and there is, we know, a vast accumulation of ice at the south pole. But when the earth's orbit is nearly circular, as it is at present, the difference between the two hemispheres is not very great; on the contrary, as the excentricity of the orbit increases the contrast between them increases also. This excentricity is continually oscillating within certain limits, which Croll and subsequently Stone have calculated out for the last million years. At present the excentricity is 0·016, and the mean temperature of the coldest month in London is about 40°. Such has been the state of things for nearly 100,000 years; but before that there was a period, beginning 300,000 years ago, when the excentricity of the orbit varied from 0·26 to 0·57. The result of this would be greatly to increase the effect due to the obliquity of the orbit; at certain periods the climate would be much warmer than at present, while at others the number of days in winter would be twenty more, and of summer twenty less than now, while the mean temperature of the coldest month would be lowered 20°. We thus get something like a date for the last glacial epoch, and we see that it was not simply a period of cold but rather one of extremes, each beat of the pendulum of temperature lasting for no less than 21,000 years. This explains the fact that, as Morlot showed in 1854, the glacial deposits of Switzerland, and, as we now know, those of Scotland, are not a single uniform layer, but a succession of strata indicating very different conditions. I agree also with Croll and Geikie in thinking that these considerations explain the apparent anomaly of the co-existence in the same gravels of arctic and tropical animals; the former having lived in the cold, while the latter flourished in the hot, periods.

It is, I think, now well established that man inhabited Europe during the milder periods of the glacial epoch. Some high authorities, indeed, consider that we have evidence of his presence in pre-glacial and even in Miocene times, but I confess that I am not satisfied on this point. Even the more recent period carries back the record of man's existence to a distance so great as altogether to change our views of ancient history.

Nor is it only as regards the antiquity and material condition of man in pre-historic times that great progress has been made. If time permitted I should have been glad to have dwelt on the origin and development of language, of custom, and of law. On all of these the comparison of the various lower races still inhabiting so large a portion of the earth's surface, has thrown much light; while even in the most cultivated nations we find survivals, curious fancies, and lingering ideas; the fossil remains as it were of former customs and religions embedded in our modern civilisation, like the relics of extinct animals in the crust of the earth.

In geology the formation of our association coincided with the appearance of Lyell's "Principles of Geology," the first volume of which was published in 1830 and the second in 1832. At that time the received opinion was that the phenomena of Geology could only be explained by violent periodical convulsions, and a high intensity of terrestrial energy culminating in repeated catastrophes. Hutton and Playfair had indeed maintained that such causes as those now in operation would, if only time enough were allowed, account for the geological structure of the earth; nevertheless the opposite view generally prevailed, until Lyell, with rare sagacity and great eloquence, with a wealth of illustration and most powerful reasoning, convinced geologists that the forces now in action are powerful enough, if only time be given, to produce results quite as stupendous as those which Science records.

As regards stratigraphical geology, at the time of the first meeting of the British Association at York, the strata between the carboniferous limestone and the chalk had been mainly reduced to order and classified, chiefly through the labours of William Smith. But the classification of all the strata lying above the chalk and below the carboniferous limestone, respectively, remained in a state of the greatest confusion. The year 1831 marks the period of the commencement of the joint labours of Sedgwick and Murchison, which resulted in the establishment of the Cambrian, Silurian, and Devonian systems. Our Pre-Cambrian strata have recently been divided by Hicks into four great groups of immense thickness, and implying, therefore, a great lapse of time; but no fossils have yet been discovered in them. Lyell's classification of the Tertiary deposits, the result of the studies which he carried on with the assistance of Deshayes and others, was published in the third volume of the "Principles of Geology" in 1833. The establishment of Lyell's divisions of Eocene, Miocene, and Pliocene, was the starting-point of a most important series of investigations by Prestwich and others of these younger deposits; as well as of the post tertiary, quaternary, or drift beds, which are of special interest from the light they have thrown on the early history of man.

As regards the physical character of the earth, two theories have been held: one, that of a fluid interior covered by a thin crust; the other, of a practically solid sphere. The former is now very generally admitted, both by astronomers and geologists, to be untenable. The prevailing feeling of geologists on this subject has been well expressed by Prof. Le Comte, who says "the whole theory of igneous agencies—which is little less than the whole foundation of theoretic geology—must be reconstructed on the basis of a solid earth."

In 1837 Agassiz startled the scientific world by his "Discours sur l'ancienne extension des Glaciers," in which, developing the observation already made by Charpentier and Venetz, that boulders had been transported to great distances, and that rocks far away from, or high

above, existing glaciers, are polished and scratched by the action of ice, he boldly asserted the existence of a "glacial period," during which Switzerland and the North of Europe were subjected to great cold, and buried under a vast sheet of ice.

The ancient poets described certain gifted mortals as privileged to descend into the interior of the earth, and have exercised their imagination in recounting the wonders there revealed. As in other cases, however, the realities of science have proved more varied and surprising than the dreams of fiction. Of the gigantic and extraordinary animals thus revealed to us, by far the greatest number have been described during the period now under review. For instance, the gigantic Cetiosaurus was described by Owen in 1838, the Dinornis of New Zealand by the same distinguished naturalist in 1839, the Mylodon in the same year, and the Archæopteryx in 1862.

In America a large number of remarkable forms have been described, mainly by Marsh, Leidy, and Cope. Marsh has made known to us the Titanosaurus, of the American (Colorado) Jurassic beds, which is, perhaps, the largest land animal yet known, being 100 feet in length, and at least 30 in height, though it seems possible that even these vast dimensions were exceeded by those of the Atlantosaurus. Nor must I omit the Hesperornis, described by Marsh in 1872, as a carnivorous, swimming ostrich, provided with teeth, which he regards as a character inherited from reptilian ancestors; the Ichthyornis, stranger still, with biconcave vertebræ, like those of fishes, and teeth set in sockets.

As giving, in a few words, an idea of the rapid progress in this department, I may mention that Morris's "Catalogue of British Fossils," published in 1843, contained 5300 species, while that now in preparation by Mr. Etheridge enumerates 15,000.

But if these figures show how rapid our recent progress has been, they also very forcibly illustrate the imperfection of the geological record, and give us, I will not say a measure, but an idea, of the imperfection of the geological record. The number of all the described recent species is over 300,000, but certainly not half are yet on our lists, and we may safely take the total number of recent species as being not less than 700,000. But in former times there have been at the very least twelve periods, in each of which by far the greater number of species were distinct. True the number of species was probably not so large in the earlier periods as at present; but if we make a liberal allowance for this, we shall have a total of more than 2,000,000 species, of which about 25,000 only are as yet upon record; and many of these are only represented by a few, some only by a single specimen, or even only by a fragment.

The progress of palæontology may also be marked by the extent to which the existence of groups has been, if I may so say, carried back in time. Thus I believe that in 1830 the earliest known quadrupeds were small marsupials belonging to the Stonesfield slates; the most ancient mammal now known is *Microlestes antiquus* from the Keuper of Würtemberg: the oldest bird known in 1831 belonged to the period of the London Clay; the oldest now known is the Archæopteryx of the Solenhofen slates, though it is probable that some at any rate of the footsteps on the Triassic rocks are those of birds. So again the Amphibia have been carried back from the Trias to the Coal-measures; Fish from the Old Red Sandstone to the Upper Silurian; Reptiles to the Trias; Insects from the Cretaceous to the Devonian; Mollusca and Crustacea from the Silurian to the Lower Cambrian. The rocks below the Cambrian, though of immense thickness, have afforded no relics of animal life, if we except the problematical *Eozoon Canadense*, so ably studied by Dawson and Carpenter. But if palæontology as yet throws no light on the original forms of life, we must remember that the simplest and the lowest organisms are so soft and perishable that they would leave "not a wrack behind."

Passing to the science of Geography, Mr. Clements Markham has recently published an excellent summary of what has been accomplished during the half-century.

But the progress in our knowledge of geography is, and has been, by no means confined to the improvement of our maps, or to the discovery and description of new regions of the earth, but has extended to the causes which have led to the present configuration of the surface. To a great extent, indeed, this part of the subject falls rather within the scope of geology; but I may here refer, in illustration, to the distribution of lakes, the phenomena of glaciers, the formation of volcanic mountains, and the structure and distribution of coral islands.

The origin and distribution of lakes is one of the most interesting problems in physical geography. That they are not scattered at random a glance at the map is sufficient to show. They abound in mountain districts, are comparatively rare in equatorial regions, increasing in number as we go north, so that in Scotland and the northern parts of America they are sown broadcast.

Perhaps *à priori* the first explanation of the origin of lakes which would suggest itself, would be that they were formed in hollows resulting from a disturbance of the strata, which had thrown them into a basin-shaped form. Lake-basins, however, of this character are, as a matter of fact, very rare; as a general rule lakes have not the form of basin-shaped synclinal hollows, but, on the contrary, the strike of the strata often runs right across them. My eminent predecessor, Prof. Ramsay, divides lakes into three classes:—(1) Those which are due to irregular accumulations of drift, and which are generally quite shallow; (2) those which are formed by moraines; and (3) those which occupy true basins scooped by glacier-ice out of the solid rock. To the latter class belong most of the great Swiss and Italian lakes. Prof. Ramsay attributes their excavation to glaciers, because it is of course obvious that rivers cannot make basin-shaped hollows surrounded by rocks on all sides. Now the Lake of Geneva, 1230 feet above the sea, is 984 feet deep; the Lake of Brienz is 1850 feet above the sea, and 2000 feet deep, so that its bottom is really below the sea-level. The Italian lakes are even more remarkable. The Lake of Como, 700 feet above the sea, is 1929 feet deep. Lago Maggiore, 685 feet above the sea, is no less than 2625 feet deep. It will be observed that these lakes, like many others in mountain regions,—those of Scandinavia, for instance,—lie in the direct channels of the great old glaciers. If the mind is at first staggered at the magnitude of the scale, we must remember that the ice which scooped out the valley in which the Lake of Geneva now reposes was once at least 2700 feet thick, while the moraines were also of gigantic magnitude—that of Ivrea, for instance, being no less than 1500 feet in height. Prof. Ramsay's theory seems, therefore, to account beautifully for a large number of interesting facts.

Passing from lakes to mountains, two rival theories with reference to the structure and origin of volcanoes long struggled for supremacy.

The more general view was that the sheets of lava and scoriæ which form volcanic zones—such, for instance, as Ætna or Vesuvius—were originally nearly horizontal, and that subsequently a force operating from below, and exerting a pressure both upwards and outwards from a central axis towards all points of the compass, uplifted the whole stratified mass and made it assume a conical form, giving rise at the same time, in many cases, to a wide and deep circular opening at the top of the cone, called by the advocates of this hypothesis a "crater of elevation."

This theory, though—as it seems to us now—it had already received its death-blow from the admirable memoirs of Scrope, was yet that most generally adopted fifty years ago, because it was considered that compact and crystalline lavas could not have consolidated on a slope exceeding 1° or 2°. In 1858, however, Sir C. Lyell conclusively showed that in fact such lavas could consolidate at a con-

siderable angle, even in some cases at more than 30°, and it is now generally admitted that though the beds of lava, &c., may have sustained a slight angular elevation since their deposition, still, in the main, volcanic cones have acquired their form by the accumulation of lava and ashes ejected from one or more craters.

The problems presented by glaciers are of very great interest. In 1843 Agassiz and Forbes proved that the centre of a glacier, like that of a river, moves more rapidly than its sides. But how and why do glaciers move at all? Rendu, afterwards Bishop of Annecy, in 1841 endeavoured to explain the facts by supposing that glacier ice enjoys a kind of ductility. The "viscous theory" of glaciers was also adopted, and most ably advocated, by Forbes, who compared the condition of a glacier to that of the contents of a tar-barrel poured into a sloping channel. We have all, however, seen long narrow fissures, a mere fraction of an inch in width, stretching far across glaciers—a condition incompatible with the ordinary idea of viscosity. The phenomenon of regelation was afterwards applied to the explanation of glacier-motion. An observation of Faraday's supplied the clue. He noticed, in 1850, that when two pieces of thawing ice are placed together they unite by freezing at the place of contact. Following up this suggestion, Tyndall found that if he compressed a block of ice in a mould it could be made to assume any shape he pleased. A straight prism, for instance, placed in a groove and submitted to hydraulic pressure, was bent into a transparent semicircle of ice. These experiments seem to have proved that a glacial valley is a mould through which the ice is forced, and to which it will accommodate itself, while, as Tyndall and Huxley also pointed out, the "veined structure of ice" is produced by pressure, in the same manner as the cleavage of slate rocks.

It was in the year 1842 that Darwin published his great work on "Coral Islands." The fringing reefs of coral presented no special difficulty. They could be obviously accounted for by an elevation of the land, so that the coral, which had originally grown under water, had been raised above the sea-level. The circular or oval shape of so many reefs, however, each having a lagoon in the centre, closely surrounded by a deep ocean, and rising but a few feet above the sea-level, had long been a puzzle to the physical geographer. The favourite theory was that these were the summits of submarine volcanoes on which the coral had grown. But as the reef-making coral does not live at greater depths than about 25 fathoms, the immense number of these reefs formed an almost insuperable objection to this theory. The Laccadives and Maldives, for instance,—meaning literally the "lac of islands" and the "thousand islands,"—are a series of such atolls, and it was impossible to imagine so great a number of craters, all so nearly of the same altitude. Darwin showed, moreover, that so far from the ring of corals resting on a corresponding ridge of rock, the lagoons, on the contrary, now occupy the place which was once the highest land. He pointed out that some lagoons—as, for instance, that of Vanikoro—contain an island in the middle; while other islands, such as Tahiti, are surrounded by a margin of smooth water, separated from the ocean by a coral reef. Now, if we suppose that Tahiti were to sink slowly, it would gradually approximate to the condition of Vanikoro; and if Vanikoro gradually sank, the central island would disappear, while on the contrary the growth of the coral might neutralise the subsidence of the reef, so that we should simply have an atoll, with its lagoon. The same considerations explain the origin of the "barrier reefs," such as that which runs, for nearly 1000 miles, along the north-east coast of Australia. Thus Darwin's theory explained the form and the approximate identity of altitude of these coral islands. But it did more than this, because it showed us that there were great areas in process of subsidence, which, though slow, was of great importance in physical geography.*

* I ought to mention that Darwin's views have recently been questioned by Semper and Murray.

Much information has also been acquired with reference to the abysses of the ocean, especially from the voyages of the *Porcupine* and the *Challenger*. The greatest depth yet recorded is near the Ladrone Islands, where a sounding of 4575 fathoms was obtained.

Ehrenberg long ago pointed out the similarity of the calcareous mud now accumulating in our recent seas to the chalk, and showed that the green sands of the geologist are largely made up of casts of Foraminifera. Clay, however, had been looked on, until the recent expeditions, as essentially a product of the disintegration of older rocks. Not only, however, are a large proportion of siliceous and calcareous rocks either directly or indirectly derived from material which has once formed a portion of living organisms, but Sir Wyville Thomson maintains that this is the case with some clays also. In that case the striking remark of Linnæus, that "fossils are not the children but the parents of rocks," will have received remarkable confirmation. I should have thought it, I confess, probable that these clays are, to a considerable extent, composed of volcanic dust.

It would appear that calcareous deposits resembling our chalk do not occur at a greater depth than 3000 fathoms; they have not been met with in the abysses of the ocean. Here the bottom consists of exceedingly fine clay, sometimes coloured red by oxide of iron, sometimes chocolate by manganese oxide, and containing with Foraminifera occasionally large numbers of siliceous Radiolaria. These strata seem to accumulate with extreme slowness: this is inferred from the comparative abundance of whales' bones and fishes' teeth, and from the presence of minute spherical particles, supposed by Mr. Murray to be of cosmic origin—in fact, to be the dust of meteorites, which in the course of ages have fallen on the ocean. Such particles no doubt occur over the whole surface of the earth, but on land they soon oxidise, and in shallow water they are covered up by other deposits. Another interesting result of recent deep-sea explorations has been to show that the depths of the ocean are no mere barren solitudes, as was until recent years confidently believed, but, on the contrary, present as many remarkable forms of life. We have, however, as yet but thrown here and there a ray of light down into the ocean abysses:—

> "Nor can so short a time sufficient be
> To fathom the vast depths of Nature's sea."

In Astronomy, the discovery in 1845 of the planet Neptune, made independently and almost simultaneously by Adams and by Le Verrier, was certainly one of the very greatest triumphs of mathematical genius. Of the minor planets four only were known in 1831, whilst the number now on the roll amounts to 220. Many astronomers believe in the existence of an intra-mercurial planet or planets, but this is still an open question. The Solar System has also been enriched by the discovery of an inner ring to Saturn, of satellites to Mars, and of additional satellites to Saturn, Uranus, and Neptune.

The most unexpected progress, however, in our astronomical knowledge during the past half-century has been due to spectrum analysis.

The dark lines in the spectrum were first seen by Wollaston, who noticed a few of them; but they were independently discovered by Fraunhofer, after whom they are justly named, and who, in 1814, mapped no fewer than 576. The first steps in "spectrum analysis," properly so called, were made by Sir J. Herschel, Fox Talbot, and by Wheatstone, in a paper read before this Association in 1835. The latter showed that the spectrum emitted by the incandescent vapour of metals was formed by bright lines, and that these lines, while, as he then supposed, constant for each metal, differed for different metals. "We have here," he said, "a mode of discriminating metallic bodies more readily than that of chemical examination, and which may hereafter be employed for useful purposes." Nay, not only can bodies thus be more readily discriminated, but, as we now know, the presence of

extremely minute portions can be detected, the 1-5,000,000th of a grain being in some cases easily perceptible.

It is also easy to see that the presence of any new simple substance might be detected, and in this manner already several new elements have been discovered, as I shall mention when we come to Chemistry.

But spectrum analysis has led to even grander and more unexpected triumphs. Fraunhofer himself noticed the coincidence between the double dark line D of the solar spectrum and a double line which he observed in the spectra of ordinary flames, while Stokes pointed out to Sir W. Thomson, who taught it in his lectures, that in both cases these lines were due to the presence of sodium. To Kirchhoff and Bunsen, however, is due the independent conception and the credit of having first systematically investigated the relation which exists between Fraunhofer's lines and the bright liner in the spectra of incandescent metals. In order to get some fixed measure by which they might determine and record the lines characterising any given substance, it occurred to them that they might use for comparison the spectrum of the sun. They accordingly arranged their spectroscope so that one-half of the slit was lighted by the sun, and the other by the luminous gases they proposed to examine. It immediately struck them that the bright lines in the one corresponded with the dark lines in the other—the bright line of sodium, for instance, with the line, or rather lines, D in the sun's spectrum. The conclusion was obvious. There was sodium in the sun! It must indeed have been a glorious moment when that thought flashed across them, and even by itself well worth all their labour.

Kirchhoff and Bunsen thus proved the existence in the sun of hydrogen, sodium, magnesium, calcium, iron, nickel, chromium, manganese, titanium, and cobalt; since which Angström, Thalen, and Lockyer have considerably increased the list.

But it is not merely the chemistry of the heavenly bodies on which light is thrown by the spectroscope; their physical structure and evolutional history are also illuminated by this wonderful instrument of research.

It used to be supposed that the sun was a dark body enveloped in a luminous atmosphere. The reverse now appears to be the truth. The body of the sun, or photosphere, is intensely brilliant; round it lies the solar atmosphere of comparatively cool gases, which cause the dark lines in the spectrum; thirdly, a chromosphere,—a sphere principally of hydrogen, jets of which are said sometimes to reach to a height of 100,000 miles or more, into the outer coating or corona, the nature of which is still very doubtful.

Formerly the red flames which represent the higher regions of the chromosphere could be seen only on the rare occasions of a total solar eclipse. Janssen and Lockyer, by the application of the spectroscope, have enabled us to study this region of the sun at all times.

It is, moreover, obvious that the powerful engine of investigation afforded us by the spectroscope is by no means confined to the substances which form part of our system. The incandescent body can thus be examined, no matter how great its distance, so long only as the light is strong enough. That this method was theoretically applicable to the light of the stars was indeed obvious, but the practical difficulties were very great. Sirius, the brightest of all, is, in round numbers, a hundred millions of millions of miles from us; and, though as big as sixty of our suns, his light when it reaches us, after a journey of sixteen years, is at most one two-thousandth-millionth part as bright. Nevertheless, as long ago as 1815 Fraunhofer recognised the fixed lines in the light of four of the stars, and in 1863 Miller and Huggins, in our own country, and Rutherford, in America, succeeded in determining the dark lines in the spectrum of some of the brighter stars, thus showing that these beautiful and mysterious lights contain many of the material substances with which we are familiar. In Aldebaran, for instance, we may infer the presence of hydrogen, sodium, magnesium, iron, calcium, tellurium, antimony, bismuth, and mercury; some of which are not yet known to occur in the sun. As might have been expected, the composition of the stars is not uniform, and it would appear that they may be arranged in a few well-marked classes, indicating differences of temperature, or, in other words, of age. Some recent photographic spectra of stars obtained by Huggins go very far to justify this view.

Thus, we can make the stars teach us their own composition with light which started from its source before we were born—light older than our Association itself.

But spectrum analysis has even more than this to tell us. The old methods of observation could determine the movements of the stars so far only as they were transverse to us; they afforded no means of measuring motion either directly towards or away from us. Now Döppler suggested in 1841 that the colours of the stars would assist us in this respect, because they would be affected by their motion to and from the earth, just as a steam-whistle is raised or lowered as it approaches or recedes from us. Everyone has observed that if a train whistles as it passes us, the sound appears to alter at the moment the engine goes by. This arises, of course, not from any change in the whistle itself, but because the number of vibrations which reach the ear in a given time are increased by the speed of the train as it approaches, and diminished as it recedes. So, like the sound, the colour would be affected by such a movement; but Döppler's method was practically inapplicable, because the amount of effect on the colour would be utterly insensible; and even if it were otherwise the method could not be applied, because, as we did not know the true colour of the stars, we have no datum line by which to measure.

A change of refrangibility of light, however, does occur in consequence of relative motion, and Huggins successfully applied the spectroscope to solve the problem. He took in the first place the spectroscope of Sirius, and chose a line known as F, which is due to hydrogen. Now, if Sirius was motionless, or rather if it retained a constant distance from the earth, the line F would occupy exactly the same position in the spectrum of Sirius as in that of the sun. On the contrary, if Sirius were approaching or receding from us, this line would be slightly shifted either towards the blue or red end of the spectrum. He found that the line had moved very slightly towards the red, indicating that the distance between us and Sirius is increasing at the rate of about twenty miles a second. So also Betelgeux, Rigel, Castor, and Regulus are increasing their distance; while, on the contrary, that of others, as for instance of Vega, Arcturus, and Pollux, is diminishing. The results obtained by Huggins on about twenty stars have since been confirmed and extended by Mr. Christie, now Astronomer Royal, in succession to Sir G. Airy, who has long occupied the post with so much honour to himself and advantage to science.

To examine the spectrum of a shooting star would seem even more difficult; yet Alexander Herschel has succeeded in doing so, and finds that their nuclei are incandescent solid bodies: he has recognised the lines of potassium, sodium, lithium, and other substances, and considers that the shooting stars are bodies similar in character and composition to the stony masses which sometimes reach the earth as aërolites.

No element has yet been found in any meteorite which was not previously known as existing in the earth, but the phenomena which they exhibit indicate that they must have been formed under conditions very different from those which prevail on the earth's surface. I may mention, for instance, the peculiar form of crystallised silica, called by Maskelyne, Asmanite; and the whole class of meteorites, consisting of iron generally alloyed with nickel, which Daubrée terms Holosiderites. The interesting discovery, however, by Nordenskiöld, in 1870, at Ovifak, of a number of blocks of iron alloyed with nickel and cobalt, in connection with basalts containing disseminated iron, has, in the words of Judd, "afforded a very important

link, placing the terrestrial and extra-terrestrial rocks in closer relations with one another."

We have as yet no sufficient evidence to justify a conclusion as to whether any substances exist in the heavenly bodies which do not occur in our earth, though there are many lines which cannot yet be satisfactorily referred to any terrestrial element. On the other hand, some substances which occur on our earth have not yet been detected in the sun's atmosphere.

Such discoveries as these seemed, not long ago, entirely beyond our hopes. M. Comte, indeed, in his "Cours de Philosophie Positive," as recently as 1842, laid it down as an axiom regarding the heavenly bodies, that "Nous concevons la possibilité de déterminer leurs formes, leurs distances, leurs grandeurs et leurs mouvements, tandis que nous ne saurions jamais étudier par aucun moyen leur composition chimique ou leur structure minéralogique." Yet within a few years this supposed impossibility has been actually accomplished, showing how unsafe it is to limit the possibilities of science.

It is hardly necessary to point out that, while the spectrum has taught us so much, we have still even more to learn. Why should some substances give few, and others many, lines? Why should the same substance give different lines at different temperatures? What are the relations between the lines and the physical or chemical properties?

We may certainly look for much new knowledge of the hidden actions of atoms and molecules from future researches with the spectroscope. It may even, perhaps, teach us to modify our views of the so-called simple substances. Prout long ago, struck by the remarkable fact that nearly all atomic weights are simple multiples of the atomic weight of hydrogen, suggested that hydrogen must be the primordial substances. Brodie's researches also naturally fell in with the supposition that the so-called simple substances are in reality complex, and that their constituents occur separately in the hottest regions of the solar atmosphere. Lockyer considers that his researches lend great probability to this view. The whole subject is one of intense interest, and we may rejoice that it is occupying the attention, not only of such men as Abney, Dewar, Hartley, Liveing, Roscoe, and Schuster in our own country, but also of many foreign observers.

When geology so greatly extended our ideas of past time, the continued heat of the sun became a question of greater interest than ever. Helmholtz has shown that, while adopting the nebular hypothesis, we need not assume that the nebulous matter was originally incandescent; but that its present high temperature may be, and probably is, mainly due to gravitation between its parts. It follows that the potential energy of the sun is far from exhausted, and that with continued shrinking it will continue to give out light and heat, with little, if any, diminution for several millions of years.

Like the sand of the sea, the stars of heaven have ever been used as effective symbols of number, and the improvements in our methods of observation have added fresh force to our original impressions. We now know that our earth is but a fraction of one out of at least 75,000,000 worlds.

But this is not all. In addition to the luminous heavenly bodies, we cannot doubt that there are countless others, invisible to us from their greater distance, smaller size, or feebler light; indeed, we know that there are many dark bodies which now emit no light or comparatively little. Thus, in the case of Procyon, the existence of an invisible body is proved by the movement of the visible star. Again, I may refer to the curious phenomena presented by Algol, a bright star in the head of Medusa. This star shines without change for two days and thirteen hours; then, in three hours and a half, dwindles from a star of the second to one of the fourth magnitude; and then, in another three and a half hours, re-assumes its original brilliancy. These changes seem certainly to indicate the presence of an opaque body, which intercepts at regular intervals a part of the light emitted by Algol.

Thus, the floor of heaven is not only "thick inlaid with patines of bright gold," but studded also with extinct stars; once probably as brilliant as our own sun, but now dead and cold, as Helmholtz tells us that our sun itself will be, some seventeen millions of years hence.

The general result of astronomical researches has been thus eloquently summed up by Proctor:—"The sidereal system is altogether more complicated and more varied in structure than has hitherto been supposed; in the same region of the stellar depths co exist stars of many orders of real magnitude; all orders of nebulæ, gaseous or stellar planetary, ring-formed, elliptical, and spiral, exist within the limits of the galaxy; and lastly, the whole system is alive with movements, the laws of which may one day be recognised, though at present they appear too complex to be understood."

We can, I think, scarcely claim the establishment of the undulatory theory of light as falling within the last fifty years; for though Brewster, in his "Report on Optics," published in our first volume, treats the question as open, and expresses himself still unconvinced, he was, I believe, almost alone in his preference for the emission theory. The phenomena of interference, in fact left hardly any—if any—room for doubt, and the subject was finally set at rest by Foucault's celebrated experiments in 1850. According to the undulatory theory the velocity of light ought to be greater in air than in water, while if the emission theory were correct, the reverse would be the case. The velocity of light—186,000 miles in a second—is, however, so great that, to determine its rate in air, as compared with that in water, might seem almost hopeless.

The velocity in air was, nevertheless, determined by Fizeau in 1849, by means of a rapidly revolving wheel. In the following year Foucault, by means of a revolving mirror, demonstrated that the velocity of light is greater in air than in water—thus completing the evidence in favour of the undulatory theory of light.

The idea is now gaining ground, that, as maintained by Clerk-Maxwell, light itself is an electro-magnetic disturbance, the luminiferous ether being the vehicle of both light and electricity.

Wünsch, as long ago as 1792, had clearly shown that the three primary colours were red, green, and violet; but his results attracted little notice, and the general view used to be that there were seven principal colours—red, orange, yellow, green, blue, indigo, and violet; four of which—namely, orange, green, indigo, and violet—were considered to arise from mixtures of the other three. Red, yellow, and blue were therefore called the primary colours, and it was supposed that in order to produce white light these three colours must always be present.

Helmholtz, however, again showed, in 1852, that a colour to our unaided eyes identical with white, was produced by combining yellow with indigo. At that time yellow was considered to be a simple colour, and this, therefore, was regarded as an exception to the general rule, that a combination of three simple colours is required to produce white. Again, it was, and indeed still is, the general impression that a combination of blue and yellow makes green. This, however, is entirely a mistake. Of course we all know that yellow paint and blue paint make green paint; but this results from absorption of light by the semi-transparent solid particles of the pigments, and is not a mere mixture of the colours proceeding unaltered from the yellow and the blue particles: moreover, as can easily be shown by two sheets of coloured paper and a piece of window glass, blue and yellow light, when combined, do not give a trace of green, but if pure would produce the effect of white. Green, therefore, is after all not produced by a mixture of blue and yellow. On the other hand, Clerk-Maxwell proved, in 1860, that yellow could be produced by a mixture of red and green, which put an end to the pretension of yellow to be considered a

primary element of colour. From these and other considerations it would seem, therefore, that the three primary colours—if such an expression be retained—are red, green, and violet.

The existence of rays beyond the violet, though almost invisible to our eyes, had long been demonstrated by their chemical action. Stokes, however, showed in 1852 that their existence might be proved in another manner, for that there are certain substances which, when excited by them, emit light visible to our eyes. To this phenomenon he gave the name of fluorescence. At the other end of the spectrum Abney has recently succeeded in photographing a large number of lines in the infra-red portion, the existence of which was first proved by Sir William Herschel.

From the rarity, and in many cases the entire absence, of reference to blue, in ancient literature, Geiger—adopting and extending a suggestion first thrown out by Mr. Gladstone—has maintained that, even as recently as the time of Homer, our ancestors were blue-blind. Though for my part I am unable to adopt this view, it is certainly very remarkable that neither the Rigveda, which consists almost entirely of hymns to heaven, nor the Zendavesta, the Bible of the Parsees or fire-worshippers, nor the Old Testament, nor the Homeric poems, ever allude to the sky as blue.

On the other hand, from the dawn of poetry, the splendours of the morning and evening skies have excited the admiration of mankind. As Ruskin says, in language almost as brilliant as the sky itself, the whole heaven, "from the zenith to the horizon, becomes one molten, mantling sea of colour and fire; every black bar turns into massy gold, every ripple and wave into unsullied shadowless crimson, and purple, and scarlet, and colours for which there are no words in language, and no ideas in the mind—things which can only be conceived while they are visible; the intense hollow blue of the upper sky melting through it all, showing here deep, and pure, and lightness; there, modulated by the filmy, formless body of the transparent vapour, till it is lost imperceptibly in its crimson and gold."

But what is the explanation of these gorgeous colours? Why is the sky blue? and why are the sunrise and sunset crimson and gold? It may be said that the air is blue, but if so how can the clouds assume their varied tints? Brücke showed that very minute particles suspended in water are blue by reflected light. Tyndall has taught us that the blue of the sky is due to the reflection of the blue rays by the minute particles floating in the atmosphere. Now, if from the white light of the sun, the blue rays are thus selected, those which are transmitted will be yellow, orange, and red. Where the distance is short the transmitted light will appear yellowish. But as the sun sinks towards the horizon the atmospheric distance increases, and consequently the number of the scattering particles. They weaken in succession the violet, the indigo, the blue, and even disturb the proportions of green. The transmitted light under such circumstances must pass from yellow through orange to red, and thus, while we at noon are admiring the deep blue of the sky, the same rays, robbed of their blue, are elsewhere lighting up the evening sky with all the glories of sunset.

Another remarkable triumph of the last half-century has been the discovery of photography. At the commencement of the century Wedgwood and Davy observed the effect produced by throwing the images of the objects on paper or leather prepared with nitrate of silver, but no means were known by which such images could be fixed. This was first effected by Niepce, but his processes were open to objections, which prevented them from coming into general use, and it was not till 1839 that Daguerre invented the process which was justly named after him. Very soon a further improvement was effected by our countryman Talbot. He not only fixed his "Talbotypes" on paper—in itself a great convenience—but, by obtaining a negative, rendered it possible to take off any number of positive, or natural, copies from one original picture.

We owe to Wheatstone the conception that the idea of solidity is derived from the combination of two pictures of the same object in slightly different perspective. This he proved in 1833 by drawing two outlines of some geometrical figure or other simple object, as they would appear to either eye respectively, and then placing them so that they might be seen, one by each eye. The "stereoscope," thus produced, has been greatly popularised by photography.

For 2000 years the art of lighting had made little if any progress. Until the close of the last century, for instance, our lighthouses contained mere fires of wood or coal, though the construction had vastly improved. The Eddystone lighthouse, for instance, was built by Smeaton, in 1759; but for forty years its light consisted in a row of tallow candles stuck in a hoop. The Argand lamp was the first great improvement, followed by gas, and in 1863 by the electric light.

Just as light was long supposed to be due to the emission of material particles, so heat was regarded as a material, though ethereal, substance, which was added to bodies when their temperature was raised.

Davy's celebrated experiment of melting two pieces of ice by rubbing them against one another in the exhausted receiver of an air-pump had convinced him that the cause of heat was the motion of the invisible particles of bodies, as had been long before suggested by Newton, Boyle, and Hooke. Rumford and Young also advocated the same view. Nevertheless, the general opinion, even until the middle of the present century, was that heat was due to the presence of a subtle fluid known as "caloric," a theory which is now entirely abandoned.

The determination of the mechanical equivalent of heat is mainly due to the researches of Mayer and Joule. Mayer, in 1842, pointed out the mechanical equivalent of heat as a fundamental datum to be determined by experiment. Taking the heat produced by the condensation of air as the equivalent of the work done in compressing the air, he obtained a numerical value of the mechanical equivalent of heat. There was, however, in these experiments one weak point. The matter operated on did not go through a cycle of changes. He assumed that the production of heat was the only effect of the work done in compressing the air. Joule had the merit of being the first to meet this possible source of error. He ascertained that a weight of 1 lb. would have to fall 772 feet in order to raise the temperature of 1 lb. of water by 1° F. Hirn subsequently attacked the problem from the other side, and showed that if all the heat passing through a steam-engine was turned into work, for every degree Fahr. added to the temperature of a pound of water enough work could be done to raise a weight of 1 lb. to a height of 772 feet. The general result is that, though we cannot create energy we may help ourselves to any extent from the great storehouse of Nature. Wind and water, the coal-bed and the forest, afford man an inexhaustible supply of available energy.

It used to be considered that there was an absolute break between the different states of matter. The continuity of the gaseous, liquid, and solid conditions was first demonstrated by Andrews in 1862.

Oxygen and nitrogen have been liquefied independently and at the same time by Cailletet and Raoul Pictet. Cailletet also succeeded in liquefying air, and soon afterwards hydrogen was liquefied by Pictet under a pressure of 650 atmospheres, and a cold of 170° C. below zero. It even became partly solidified, and he assures us that it fell on the floor with "the shrill noise of metallic hail." Thus then it was shown experimentally that there are no such things as absolutely permanent gases.

The kinetic theory of gases, now generally accepted, refers the elasticity of gases to a motion of translation of their molecules, and we are assured that in the case of hydrogen, at a temperature of 60° F., they move at an

average rate of 6225 feet in a second; while as regards their size, Loschmidt, who had since been confirmed by Stoney and Sir W. Thomson, calculates that each is at most 1-50,000,000th of an inch in diameter.

We cannot, it would seem at present, hope for any increase of our knowledge of atoms by any improvement in the microscope. With our present instruments we can perceive lines ruled on glass of 1-90,000th of an inch apart. But, owing to the properties of life itself, the fringes due to interference begin to produce confusion at distances of 1-74,000. It would seem then that, owing to the physical characters of light, we can, as Sorby has pointed out, scarcely hope for any great improvement so far as the mere visibility of structure is concerned, though in other respects no doubt much may be hoped for.

Sorby is of opinion that in a length of 1-80,000th of an inch there would probably be from 500 to 2000 molecules —500, for instance, in albumen, and 2000 in water. Even, then, if we could construct microscopes far more powerful than any we now possess, they would not enable us to obtain by direct vision any idea of the ultimate molecules of matter. Sorby calculates that the smallest sphere of organic matter which could be clearly defined with our most powerful microscopes would contain many millions of molecules of albumen and water, and it follows that there may be an almost infinite number of structural characters in organic tissues, which we can at present foresee no mode of examining.

Electricity in the year 1831 may be considered to have just been ripe for its adaptation to practical purposes: it was but a few years previously, in 1819, that Oersted had discovered the deflective action of the current on the magnetic needle, that Ampère had laid the foundation of electro-dynamics, that Schweizzer had devised the electric coil or multiplier, and that Sturgeon had constructed the first electro-magnet. It was in 1831 that Faraday, the prince of pure experimentalists, announced his discoveries of voltaic induction and magneto-electricity, which with the other three discoveries constitute the principles of nearly all the telegraph instruments now in use; and in 1834 our knowledge of the nature of the electric current had been much advanced by the interesting experiment of Sir Charles Wheatstone, proving the velocity of the current in a metallic conductor to approach that of the wave of light.

Practical applications of these discoveries were not long in coming to the fore, and the first telegraph line on the Great Western Railway from Paddington to West Drayton was set up in 1838. In America Morse is said to have commenced to develop his recording instrument between the years 1832 and 1837.

In 1851 submarine telegraphy became an accomplished fact through the successful establishment of telegraphic communication between Dover and Calais. Submarine lines followed in rapid succession, crossing the English Channel and the German Ocean, threading their way through the Mediterranean, Black and Red Seas, until in 1866, after two abortive attempts, telegraphic communication was successfully established between the Old and New Worlds, beneath the Atlantic Ocean.

Duplex and quadruplex telegraphy, one of the most striking achievements of modern telegraphy, the result of the labours of several inventors, should not be passed over in silence. It not only serves for the simultaneous communication of telegraphic intelligence in both directions, but renders it possible for four instruments to be worked irrespectively of one another, through one and the same wire connecting two distant places.

Another more recent and perhaps still more wonderful achievement in modern telegraphy is the invention of the telephone and microphone, by means of which the human voice is transmitted through the electric conductor, by mechanism that imposes through its extreme simplicity. In this connection the names of Reiss, Graham Bell, Edison, and Hughes, are those chiefly deserving to be recorded.

By the electric transmission of power we may hope some day to utilise at a distance such natural sources of energy as the Falls of Niagara, and to work our cranes, lifts, and machinery of every description by means of sources of power arranged at convenient centres. To these applications the Brothers Siemens have more recently added the propulsion of trains by currents passing through the rails, the fusion in considerable quantities of highly refractory substances, and the use of electric centres of light in horticulture as proposed by Werner and William Siemens. By an essential improvement by Faure of the Planté Secondary Battery, the problem of storing electrical energy appears to have received a practical solution, the real importance of which is clearly proved by Sir W. Thomson's recent investigation of the subject.

It would be difficult to assign the limits to which this development of electrical energy may not be rendered serviceable for the purposes of man.

As regards Mathematics I have felt that it would be impossible, even with the kindest help, to write anything myself. Mr. Spottiswoode, however, has been so good as to supply me with the following memorandum.

In a complete survey of the progress of Science during the half-century which has intervened between our first and our present meeting, the part played by mathematics would form no insignificant feature. To those indeed who are outside its enchanted circle it is difficult to realise the intense intellectual energy which actuates its devotees, or the wide expanse over which that energy ranges.

In the extension of mathematics it has happened more than once that laws have been established so simple in form, and so obvious in their necessity, as scarcely to require proof. And yet their application is often of the highest importance in checking conclusions which have been drawn from other considerations, as well as in leading to conclusions which, without their aid, might have been difficult of attainment. The same thing has occurred also in physics; and notably in the recognition of what has been termed the "Law of the Conservation of Energy."

Energy has been defined to be "The capacity, or power, of any body, or system of bodies, when in a given condition, to do a measureable quantity of work." Such work may either change the condition of the bodies in question, or it may affect other bodies; but in either case energy is expended by the agent upon the recipient in performance of the work. The law then states that the total amount of energy in the agents and recipients taken together remains unaltered by the changes in question.

Now the principle on which the law depends is this: that every kind of change among the bodies may be expressed numerically in one standard unit of change, viz., work done, in such wise that the result of the passage of any system from one condition to another may be calculated by mere additions and subtractions, even when we do not know how the change came about.

The history of a discovery, or invention, so simple at first sight, is often found to be more complicated the more thoroughly it is examined. That which at first seems to have been due to a single mind proves to have been the result of the successive action of many minds. Attempts more or less successful in the same direction are frequently traced out; and even unsuccessful efforts may not have been without influence on minds turned towards the same object. Lastly also, germs of thought, originally not fully understood, sometimes prove in the end to have been the first stages of growth towards ultimate fruit. The history of the law of the conservation of energy forms no exception to this order of events. There are those who discern even in the writings of Newton expressions which show that he was in possession of some ideas which, if followed out in a direct line of thought, would lead to those now entertained on the subjects of energy and of work. But however this may be, and whosoever might

be reckoned among the earlier contributors to the general subjects of energy, and to the establishment of its laws, it is certain that within the period of which I am now speaking, the names of Seguin, Clausius, Helmholtz, Mayer, and Colding, on the Continent, and those of Grove, Joule, Rankine, and Thomson, in this country, will always be associated with this great work.

Prof. Frankland has been so good as to draw up for me the following account of the progress of chemistry during the last half century.

Most of the elements had been discovered before 1830, the majority of the rarer elements since the beginning of the century. In addition to these the following five have been discovered, three of them by Mosander, viz.:—Lanthanum in 1839, didymium in 1842, and erbium in 1843. Ruthenium was discovered by Claus in 1843, and niobium by Rose in 1844. Spectrum Analysis has added five to the list, viz.:—Cæsium and rubidium, which were discovered by Bunsen and Kirchhoff in 1860; thallium, by Crookes in 1861; indium, by Reich and Richter in 1863; and gallium, by Lecoq de Boisdaudran in 1875.

In organic chemistry the views most generally held about the year 1830 were expressed in the radical theory of Berzelius. This theory, which was first stated in its electro-chemical and dualistic form by its author in 1817, received a further development at his hands in 1834 after the discovery of the benzoyl-radical by Liebig and Wöhler. In the same year (1834), however, a discovery was made by Dumas, which was destined profoundly to modify the electro-chemical portion of the theory, and even to overthrow the form of it put forth by Berzelius. Dumas showed that an electro-negative element, such as chlorine, might replace, atom for atom, an electro-positive element like hydrogen, in some cases without much alteration in the character of the compound. This law of substitution has formed a necessary portion of every chemical theory which has been proposed since its discovery, and its importance has increased with the progress of the science.

Chemists have been engaged in determining, by means of decompositions, the molecular architecture, or *constitution* as it is called, of various compounds, natural and artificial, and in verifying by synthesis the correctness of the views thus arrived at.

It was long supposed that an impassable barrier existed between inorganic and organic substances: that the chemist could make the former in his laboratory, while the latter could only be produced in the living bodies of animals or plants,—requiring for their construction not only chemical attractions, but a supposed "vital force." It was not until 1828 that Wöhler broke down this barrier by the synthetic production of urea, and since his time this branch of science in the hands of Hofmann has made great strides.

In connection with the rectification of the atomic weights it may be mentioned that a so-called natural system of the elements has been introduced by Mendelejeff (1869), in which the properties of the elements appear as a periodic function of their atomic weights. By the aid of this system it has been possible to predict the properties and atomic weights of undiscovered elements, and in the case of known elements to determine many atomic weights which had not been fixed by any of the usual methods. Several of these predictions have been verified in a remarkable manner. A periodicity in the atomic weights of elements belonging to the same class had been pointed out by Newlands about four years before the publication of Mendelejeff's memoir.

In mechanical science the progress has not been less remarkable than in other branches. Indeed to the improvements in mechanics we owe no small part of our advance in practical civilisation, and of the increase of our national prosperity during the last fifty years.

This immense development of mechanical science has been to a great extent a consequence of the new processes which have been adopted in the manufacture of iron, for the following data with reference to which I am indebted to Captain Douglas Galton. About 1830, Neilson introduced the hot blast in the smelting of iron. At first a temperature of 600° or 700° Fahrenheit was obtained, but Cowper subsequently applied Siemens's regenerative furnace for heating the blast, chiefly by means of fumes from the black furnace, which were formerly wasted; and the temperature now practically in use is as much as 1400° or even more: the result is a very great economy of fuel and an increase of the output.

Bessemer, by his brilliant discovery, which he first brought before the British Association at Cheltenham in 1856, showed that Iron and Steel could be produced by forcing currents of atmospheric air through fluid pig-metal, thus avoiding for the first time the intermediate process of puddling iron, and converting it by cementation into steel.

The inventions of Cort and others were known long before 1830, but we were then still without the most powerful tool in the hands of the practical metallurgist, viz., Nasmyth's steam hammer.

Steel can now be produced as cheaply as iron was formerly; and its substitution for iron as railway material and in shipbuilding, has resulted in increased safety in railway travelling, as well as in economy, from its vastly greater durability.

The introduction of iron has, moreover, had a vast influence on the works of both the civil and military engineer. Before 1830, Telford had constructed an iron suspension turnpike-road bridge of 560 feet over the Menai Straits; but this bridge was not adapted to the heavy weights of locomotive engines. At the present time, with steel at his command, Mr. Fowler is engaged in carrying out the design for a railway bridge over the Forth, of two spans of 1700 feet each; that is to say, of nearly one third of a mile in length.

As regards railways, the Stockton and Darlington Railway was opened in 1825, but the Liverpool and Manchester Railway, perhaps the first truly passenger line, dates from 1830, while the present mileage of railways is over 200,000 miles, costing nearly £4,000,000,000 sterling. It was not until 1838 that the *Sirius* and *Great Western* first steamed across the Atlantic. The steamer, in fact, is an excellent epitome of the progress of the half-century; the paddle has been superseded by the screw; the compound has replaced the simple engine; wood has given place to iron, and iron in its turn to steel. The saving in dead weight, by this improvement alone, is from 10 to 16 per cent. The speed has been increased from 9 knots to 15, or even more. Lastly, the steam-pressure has been increased from less than 5lbs. to 70lbs. per square inch, while the consumption of coal has been brought down from 5 or 6lbs. per horse-power to less than 2. It is a remarkable fact that not only is our British shipping rapidly on the increase, but it is increasing relatively to that of the rest of the world. In 1860 our tonnage was 5,700,000 against 7,200,000; while it may now be placed as 8,500,000 against 8,200,000; so that considerably more than half the whole shipping of the world belongs to this country.

If I say little with reference to economic science and and statistics it is because time, not materials, are wanting.

I scarcely think that in the present state of the question I can be accused of wandering into politics if I observe that the establishment of the doctrine of free trade as a scientific truth falls within the period under review.

In education some progress has been made towards a more rational system. When I was at a public school, neither science, modern languages, nor arithmetic formed any part of the school system. This is now happily changed. Much, however, still remains to be done. Too little time is still devoted to French and German, and it

is much to be regretted that even in some of our best schools they are taught as dead languages. Lastly, with few exceptions, only one or two hours on an average are devoted to science. We have, I am sure, none of us any desire to exclude, or discourage, literature. What we ask is that, say, six hours a week each should be devoted to mathematics, modern languages, and science, an arrangement which would still leave twenty hours for Latin and Greek. I admit the difficulties which schoolmasters have to contend with; nevertheless, when we consider what science has done and is doing for us, we cannot but consider that our present system of education is, in the words of the Duke of Devonshire's Commission, little less than a national misfortune.

In agriculture the changes which have occurred in the period since 1831 have been immense. The last half century has witnessed the introduction of the modern system of subsoil drainage founded on the experiments of Smith of Deanston. The thrashing and drilling machines were the most advanced forms of machinery in use in 1831. Since then then there have been introduced the steam-plough; the mowing-machine; the reaping-machine, which not only cuts the corn but binds it into sheaves; while the steam-engine thrashes out the grain and builds the ricks. Science has thus greatly reduced the actual cost of labour, and yet it has increased the wages of the labourer.

It was to the British Association, at Glasgow in 1841, that Baron Liebig first communicated his work "On the Application of Chemistry to Vegetable Physiology," while we have also from time to time received accounts of the persevering and important experiments which Mr. Lawes, with the assistance of Dr. Gilbert, has now carried on for more than forty years at Rothamstead, and which have given so great an impulse to agriculture by directing attention to the principles of cropping, and by leading to the more philosophical application of manures.

I feel that in quitting Section F so soon, I owe an apology to our fellow-workers in that branch of science, but I doubt not that my short-comings will be more than made up for by the address of their excellent President, Mr. Grant-Duff, whose appointment to the Governorship of Madras, while occasioning so sad a loss to his friends, will unquestionably prove a great advantage to India, and materially conduce to the progress of science in that country.

Moreover, several other subjects of much importance, which might have been referred to in connection with these latter Sections, I have already dealt with under their more purely scientific aspect.

Indeed one very marked feature in modern discovery is the manner in which distinct branches of science have thrown, and are throwing, light on one another. Thus the study of geographical distribution of living beings, to the knowledge of which our late general secretary, Mr. Sclater, has so greatly contributed, has done much to illustrate ancient geography. The existence of high northern forms in the Pyrenees and Alps points to the existence of a period of cold when Arctic species occupied the whole of habitable Europe. Wallace's line—as it has been justly named after that distinguished naturalist—points to the very ancient separation between the Malayan and Australian regions; and the study of corals has thrown light upon the nature and significance of atolls and barrier-reefs.

In studying the antiquity of man, the archæologist has to invoke the aid of the chemist, the geologist, the physicist, and the mathematician. The recent progress in astronomy is greatly due to physics and chemistry. In geology the composition of rocks is a question of chemistry; the determination of the boundaries of the different formations falls within determination of the limits of geography; while palæontology is the biology of the past.

And now I must conclude. I fear I ought to apologise to you for keeping you so long, but still more strongly do I wish to express my regret that there are almost innumerable researches of great interest and impo,tance which fall within the last fifty years (many even among those with which our Association has been connected) to which I have found it impossible to refer. Such for instance are, in biology alone, Owen's memorable report on the homologies of the vertebrate skeleton, Carpenter's laborious researches on the microscopic structure of shells, the reports on marine zoology by Allman, Forbes, Jeffreys, Spence Bate, Norman, and others; on Kent's Cavern by Pengelly, those by Duncan on corals; Woodward on crustacea; Carruthers, Williamson, and others on fossil botany, and many more. Indeed no one who has not had occasion to study the progress of science throughout its various departments can have any idea how enormous—how unprecedented—the advance has been.

Though it is difficult, indeed impossible, to measure exactly the extent of the influence exercised by this Association, no one can doubt that it has been very considerable. For my own part, I must acknowledge with gratitude how much the interest of my life has been enhanced by the stimulus of our meetings, by the lectures and memoirs to which I have had the advantage of listening, and above all, by the many friendships which I owe to this Association.

Summing up the principal results which have been attained in the last half-century we may mention (over and above the accumulation of facts) the theory of evolution, the antiquity of man, and the far greater antiquity of the world itself; the correlation of physical forces and the conservation of energy; spectrum analysis and its application to celestial physics; the higher algebra and the modern geometry; lastly, the innumerable applications of science to practical life—as, for instance, in photography, the locomotive engine, the electric telegraph, the spectroscope, and most recently the electric light and the telephone.

To science, again, we owe the idea of progress. The ancient, says Bagehot, "had no conception of progress; they did not so much as reject the idea; they did not even entertain it.' It is not,' I think, now going too far to say that the true test of the civilisation of a nation must be measured by its progress in science. It is often said, however, that great and unexpected as the recent discoveries have been, there are certain ultimate problems which must ever remain unsolved. For my part I would prefer to abstain from laying down any such limitations. When Park asked the Arabs what became of the sun at night, and whether the sun was always the same, or new each day, they replied that such a question was childish and entirely beyond the reach of human investigation. I have already mentioned that, even as lately as 1842, so high an authority as Comte treated as obviously impossible and hopeless any attempt to determine the chemical composition of the heavenly bodies. Doubtless there are questions the solution of which we do not as yet see our way even to attempt; nevertheless the experience of the past warns us not to limit the possibilities of the future.

But however this may be, though the progress made has been so rapid, and though no similar period in the world's history has been nearly so prolific of great results, yet, on the other hand, the prospects of the future were never more encouraging. We must not, indeed, shut our eyes to the possibility of failure; the temptation to military ambition; the tendency to over-interference by the state; the spirit of anarchy and socialism; these and other elements of danger may mar the fair prospects of the future. That they will succeed, however, in doing so, I cannot believe. I cannot but feel confident hope that fifty years hence, when perhaps the city of York may renew its hospitable invitation, my successor in this chair—more competent, I trust, than I have been to do justice to so grand a theme—will have to record a series of discoveries even more unexpected and more brilliant than those which I have, I fear so imperfectly, attempted to bring before you this evening, for one great lesson which science teaches is, how little we yet know, and how much we have still to learn.

CORRESPONDENCE.

FRAUDULENT ALTERATION OF CHEQUES.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliv., p. 25, it is stated that Messrs. Skipper and East have obtained from Messrs. Dupré and Hehner a process to prevent the fraudulent alteration of cheques, consisting in the use of a mixture of zinc sulphate and lead carbonate.

We beg to inform you that the process described is one which has been in use by us for years past, and that the patent is, therefore, anticipated.—I am, &c.,

Perkins, Bacon, and Co.

69, Fleet Street, August 30, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Moniteur Scientifique, Quesneville.
July, 1881.

Industrial Society of Mulhouse.—Session of June 8.—M. Witt gave a short notice of his researches upon the diamines, which have led to the discovery of two new colouring-matters, "neutral violet" and "neutral red," now manufactured by the firm of Casella, of Frankfurt.

M. Scheurer called the attention of the Committee to a note by M. Fergusson, presented to the Academy of Sciences February 28, 1881, on the antiputrescent properties of nitrous ether. This substance may be usefully employed for the preservation of solutions of albumen.

M. Prud'homme, on behalf of M. Romann, of Barcelona, presented a note on a new method of producing upon tissues metallic sulphides, and especially that of cadmium, by means of the xanthates.

Lectures by M. Georges Ville.—This distinguished agricultural chemist has been giving a course of lectures every Sunday, at 2 p.m., at his experimental field at Vincennes. He has undertaken the cultivation of a plot of 250 hectares, the better to illustrate his system, and to show French agriculturists how to encounter American competition.

Journal für Praktische Chemie.
No. 7, 1881.

Action of Phosphorus Oxychloride upon Potassium and Sodium Salicylates, Neutral and Basic.—R. Richter.—In this preliminary communication the author treats of a keton, $(C_{12}H_8O)CO$, melting at 170°, and of an isomer, melting at 91°.

Nos. 8 and 9, 1881.

My Share in the Development of Theoretical Chemistry.—H. Kolbe.—A continuation from No. 7.

The Compounds of Certain Solid Hydroxides with Acids, Salts, and Alkalies (Conclusion).—J. M. van Bemmelen.

Trimethyl Sulphine Salts.—Prof. Crum-Brown and A. Blaikie.—From the *Transactions* of the Royal Society of Edinburgh.

Green-stones.—T. Petersen.—This paper treats of melaphyr and its varieties.

Contributions to a Knowledge of the Chemical Composition of the Zygomycetes.—N. Sieber.—The albumenoids in these moulds differ little in quantity whether grown on gelatin or on sugar. The ash is very low in specimens produced on sugar and sal-ammoniac, where cellulose forms more than the half of the dry matter.

Phloron and Xyloquinon.—E. Carstanjen.—Phloron consists of two distinct and non-isomeric quinons, toluquinon and xyloquinon. The author finds that the quinon is derived from para-xylol, and is consequently a para-xyloquinon.

Conversion of Paramido-phenol into Tri- and Tetrachlor-quinon, also into Tri-chloramido-phenol and Tri-chlor-quinon-chlorimide.—R. Schmidt and M. Andresen.—A preliminary communication.

The Compounds of the Meconic Acid Group.—H. Ost.—An account of meconic acid, of certain derivatives of comenic acid, amido-comenic acid, oxy-comenic acid, comenamid, pyromecazonic acid, oxy-pyromecazonic acid, diacetyl-pyromecazonic acid, pyromecazon, and nitro-pyromecazon.

Anthology of Modern Chemical Utterances.—H. Kolbe.—Instances of confused and unintelligible language from the writings of modern chemists.

No. 10, 1881.

Contribution to a Knowledge of the Oil of Wine. E. C. Hartwig.—The author remarks that all existing researches on the oil of wine relate to a product obtained either by the distillation of the sulphethylates, or as a by-product from the preparation of ethylic ether from alcohol and sulphuric acid on the small scale. No examination has been made of the oil of wine obtained in considerable quantity during the technical preparation of ether. This oil proves to be essentially distinct, both from the "heavy" and the "light" oil of wine as examined by previous authorities. From the former it is distinguished by the absence of sulphur, and by its permanence when boiled with water or alkalies. From the latter it is distinguished by its variable composition, being a mixture of hydrocarbons, ethers, and ketons. Among hydrocarbons "di-iso-amylene," $C_{10}H_{20}$, was obtained. An ethyl-amin-ether was recognised in the fraction boiling between 110° to 120°. Two ketons were obtained in a state of purity, an ethyl-amyl-keton and a methyl-hexyl-keton.

Crystalline Albumenoids from Various Oil-Seeds.—H. Ritthausen.—The author has obtained crystalline albumen from the press-cake of hemp seed. Under the microscope it appears in well developed forms belonging to the regular system. Similar albumens were obtained from the press-cakes of castor oil and sesame.

Behaviour of Iodine with Arsenic Sulphide at Elevated Temperatures.—R. Schneider.—On cautiously heating a mixture of 107 parts arsen-disulphide and 127 parts iodine with exclusion of air, a compound is obtained of the composition AsSI.

Remarks on Lossen's Treatise, "On the Distribution of Atoms in the Molecule."—H. Kolbe.—The author shows the incomprehensibility of many of Lossen's views.

No. 11, 1881.

My Share in the Development of Theoretical Chemistry.—H. Kolbe.—Continued from the 8th and 9th number.

Determinations of Chemical Affinity (4th treatise).—Dr. W. Ostwald.—The relative affinity, $HCl : HNO_3$, has been repeatedly determined by the experiments of J. Thomsen and the author, and found = 0·98. With increasing dilution and temperature the proportional numbers approach this value more and more. The true affinity of sulphuric acid must be placed nearly equal to that of nitric or hydrochloric acid. By the formation of acid salts sulphuric acid appears always weaker than it really is. Its true affinity is still unknown, but must at least amount to 0·9 ($HNO_3 = 1$).

THE CHEMICAL NEWS.

Vol. XLIV. No. 1137.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By Prof. A. W. WILLIAMSON, Ph.D., LL.D., F.R.S., V.P.C.S., President of the Section.

On the Growth of the Atomic Theory.

It has been thought desirable that on the occasion of this half-centenary celebration of the foundation of this great Association some notice should be presented to the members of what has been doing in the respective branches of science during the period of our activity; and I have, accordingly, traced out for your consideration a very imperfect sketch of the theories which guided chemical inquiry at the beginning of that period, and of the leading changes which have been wrought in them by fifty years' work.

There is perhaps hardly any branch of science which during the last fifty years has made such great and steady progress as chemistry. Let anyone compare recent dictionaries of the science (including the bulky supplements, which contain a record of the chief discoveries made while the body of the work was being compiled) with a treatise of chemistry fifty years old. Let him compare a published record of one year's progress of the science fifty years ago with one of modern date. Let him compare, as far as may be possible, the number of men who formerly devoted their whole time and energy to the advancement of chemistry, or who were engaged in industrial pursuits involving a knowledge of the science, with the corresponding number nowadays. Let him count up the services which chemistry had rendered to common life at the commencement of the epoch with those which it has now to show.

Everywhere he will see marvellous evidences of increasing growth. But if he be a reflecting man, he will not be satisfied with wondering at results: he will endeavour to trace them to their causes, and to discover the guiding principles which have brought them about: he will try to derive, from a knowledge of those guiding principles, a perception of the means by which such progress can best be continued and extended—how it can be most effectively directed to the benefit of his fellow-men.

It is on this aspect of the question that I propose to address you to-day.

The process of scientific investigation includes a great variety of operations, which may be considered under three headings, mental, sensual, and physical. We think, we observe, and we work with our hands. In planning a new experiment we call to mind what is known of the phenomena in question, and form an opinion as to what is likely to happen under conditions somewhat different from those which existed in previous experiments. We regulate by careful observations the necessary manual operations, so as to obtain with accuracy the desired conditions for the new experiment, and we observe attentively the changes which take place in the course of that experiment. The result of such observations is sometimes in accordance with our anticipation, but very frequently at variance with it. If it accords with our anticipation, we put on record the extension which it has given to the application of the general theory on which that anticipation was founded. But if the result is not what we expected, we carefully and critically revise the reasoning which had led us to expect a particular result, and often repeat the same experiment with greater care, or some modification of it.

Materials for a new theory are gained when logically faultless reasoning, checked by accurate observations, have led to results which could not have been foreseen by the aid of any previous theory. When a theory has thus gained a footing in science, it serves as a guide in further work. It guides us in arranging known facts. It guides us to the discovery of new facts. Sometimes it does these things for a short time only, and is then superseded by some more general theory derived from a wider and more comprehensive view of the facts.

There is, perhaps, nowhere so severe and rigorous a test of the truth of an idea as that which is afforded by its use in any accurate department of experimental science; and it is worth while, on philosophical grounds, to consider briefly the conditions of growth of the chief chemical theories which have withstood this ordeal and proved themselves to be trustworthy guides in experimental science.

Now as far as I know them, the general theories which have played the chief part in the development of chemistry are mere condensed statements of fact.

Every thoughtful man of science has doubtless indulged in speculations to find the cause of facts which are as yet unexplained; has imagined some fundamental condition or property of matter which might cause it to produce effects such as are witnessed. It is to be hoped that the time may be far distant when men of science will confine their thoughts within the range of ideas which are proved to be true. But it is most important that they should not confuse such hypothetical speculations with theories which have received experimental verification, and that while employing any theory they should not lose sight of the limits within which it has been proved to be correct, beyond which it can only be used as a hypothesis.

The foundation of the science of chemistry was laid by the discovery of chemical elements; those distinct varieties of matter which we can neither produce nor destroy. Chemical science treats of those changes of property in matter which can be represented as due to changes of combination of elementary atoms. It knows nothing of the production or destruction of those elementary atoms. Speculations respecting their ultimate form or structure will have found a place in the science as soon as such speculations have helped to arrange the facts which are known, and to discover new chemical facts.

At the commencement of our epoch chemists had classified elements according to their electro-chemical properties. Chemical analysis had established the fact that a good many compounds could be represented as consisting of elementary atoms of two kinds combined in small number. Thus carbonic oxide and carbonic acid had been found to possess respectively a composition which could be represented (adopting our present atomic symbols) by the formulæ CO and CO_2, water by the formula H_2O, marsh gas CH_4, olefiant gas CH_2. The oxides and acids of nitrogen were represented by formulæ corresponding empirically to those which we now adopt. So also ammonia and hydric chloride had their present formulæ. Sulphurous and sulphuric acid had the respective formulæ SO_2 and SO_3. Phosphorus and phosphoric acid had the formulæ P_2O_3 and P_2O_5. Baryta and the oxides of iron had the formulæ BaO, FeO, Fe_2O_3.

Such primary compounds were classified upon the same principles which served for the classification of the elements themselves, into electro-positive or basylous and electro-negative or chlorous compounds, and the smallest quantity of each of them, which consistently with an atomic representation of the results of analysis, was deemed capable of existing, was called an atom of that compound.

Very simple compounds possessed of prominent characteristics and distinct reactions had first been isolated and identified. They were found to contain their constituent elements in proportions easily recognisable as multiples of atomic weights. But such simple compounds are rare exceptions among mineral and organic materials, and if

the atomic theory could have gone no further than to guide us to an understanding of these few simple compounds, it must soon have given place to some more fundamental conception. It is moreover worthy of notice that in this its most elementary form the atomic theory was not the only conceivable interpretation of the proportions of combination between elements. Those proportions could be as consistently represented by fractions as by integral multiples. Thus, instead of representing carbonic acid as containing twice as much oxygen as is contained in carbonic oxide, we might have represented it as containing the same quantity of oxygen combined with half as much carbon, and using for the moment atomic symbols for a non-atomic theory, we might have written carbonic acid thus $\frac{C}{2}O$. Or we might represent them both by percentage numbers.

It was so simple and natural to adopt the atomic hypothesis, and to represent compounds as built up of atoms, that chemists seem to have paid little attention to any other mode of representing the proportions of combination. They assumed that the variable proportions of elements, which were observed in compounds, were due to the various numbers of elementary atoms respectively aggregated together in each compound. They perceived that the existence of elementary atoms involved the existence of compound atoms, or molecules, as we now call them, and accordingly they represented each known compound of two elements by a molecular formula as simple as possible, consistently with the view of its atomic constitution. Many of these molecules, such as those of the acids, were found to be capable of combining with others of the other class, forming salts, and those combinations were found to take place in proportions corresponding to the weights of the respective molecules, or to very simple multiples of those weights, and the secondary compounds or salts thus formed combined (if at all) in proportions corresponding to simple multiples of their molecular weights. The dualistic representation of the constitution of salts served io represent the results of their analysis consistently with the atomic theory, and a vast number of fundamental facts were collected and arranged by the aid of the dualistic theory of combination.

The actual numbers obtained by analysis of any particular compound exhibited sometimes a very near approximation to those required by an atomatic formula of its composition. Sometimes they differed considerably from those required by theory; but it was always found that the more pure in substance and the more accurate the analytical operations, the more nearly did the result agree with some atomic formula of the substance.

The compound atoms were units which had grown out of the atomic theory. Each of them was the smallest quantity of a compound, which (consistently with the results of analysis) could be represented as built dualistically of its constituent atoms.

Chemical combination was viewed as a process of juxtaposition, of simple or compound atoms, little account being taken of the disturbance of the previous arrangement of those compound atoms. It was when a constitution, similar to that attributed to salts, was imagined for other compounds not saline in their character, that the dualistic theory broke down. Thus chlorocarbonic acid was represented as a compound of carbonic acid with carbonic chloride, and was accordingly designated as carbonate of carbonic chloride, while the formula was made to contain the formulæ of those bodies. Chlorosulphuric acid and chlorochromic acid were in like manner represented as compounds of sulphuric and chromic acid respectively with imaginary hexachlorides.

Careful investigations of the reactions in which chlorocarbonic acid takes part showed, however, that in each of them it behaves as a compound containing only two atoms of chlorine. It was found that the commonest and best known carbonates and sulphates have a fundamentally similar constitution. Thus potassic carbonate may be represented as a compound in which the two atoms of chlorine in phosgene are replaced by two atoms of the radica OK; and oil of vitriol, as a compound of two atoms of hydroxyl with the same group, SO_2, which in chlorosulphuric acid is combined with two atoms of chlorine. Chlorochromic acid has not been examined to as great an extent as the above compounds, but all we know of it points clearly to its having molecular constitution similar to that of chlorosulphuric acid, viz., Cl_2CrO_2, for not only do their vapour-densities agree, but the chromates in their constitution and crystalline forms exhibit a clear analogy to the sulphates.

Moreover, the simpler molecular formulæ, which a fuller knowledge of their chemical behaviour suggested for these bodies, were found in all cases to agree with the volume belonging to the molecule of every pure substance known in the state of vapour.

A difficulty of another kind had been foreseen by the great founder of the dualistic system, and it was by the investigations in organic chemistry that it assumed serious proportions.

Carbon compounds were discovered possessing definite and specific properties, and presenting the characteristics of pure substances, but of which the results of analysis did not agree with any simple proportion between the numbers of their constituent atoms. Their empirical composition could not be decided by the aid of the so-called law of multiple proportions, for two or more atomic formulæ required percentages of the constituents differing so little from one another that analysis could not decide which was the true one.

In order to select the true molecular formulæ of such complex substances from among those which approached most nearly to the results of ultimate analysis, and to determine with certainty their empirical composition, it was necessary to find other methods for the determination of molecular weights. It was necessary to study the various properties of compounds of known composition, and of others which could be prepared in a state of purity; to determine the vapour-densities and rates of diffusion of those which could be obtained in the gaseous state without decomposition; to determine boiling-points and melting-points; to examine crystalline forms of pure compounds and of mixtures; to determine solubilities and densities of solids and of liquids; but above all it was necessary to collect fuller and more accurate knowledge of the chemical changes which take place in the mutual reaction of molecules.

A vast amount of accurate and careful work of these kinds has been done, and has been subjected to rigid and often hostile scrutiny during the various steps of its progress. We now know that compound atoms, or molecules as we call them, which can be identified by their geometrical, mechanical, and other properties, are the same as the compound atoms indicated by the most comprehensive chemical evidences of composition and reactions. The molecular constitution of matter was predicted implicitly by the atomic theory of the constitution of the elements; and, wherever the physical properties of the molecules are such as afford any basis for the determination of their relative weights, such results agree with those derived from purely chemical consideration guided by the atomic theory.

Our knowledge of molecules is as yet in its infancy. Even among the commonest elements and compounds we know the molecular weights of very few, but what we do know of them proves that the idea of compound atoms invented by chemists to explain the elementary facts of chemical action is, as far as it goes, a true representation of what exists in nature.

Many of the molecules thus proved to exist were the same as those suggested under the dualistic system; but many were proved, by the more accurate and extensive knowledge of their reactions and properties, to have a different weight from that which had been at first attributed to them, yet always consistent with the fundamental requirements of the atomic theory. Thus H_2O, CO, CO_2, CH_4,

SO_2, SO_3, CaO, FeO, Fe_2O_3, are the formulæ still used to denote the molecules of the respective compounds, though the last three ought probably to be represented by some multiple. On the other hand, the molecule of olefiant gas is now represented by the formula C_2H_4, instead of CH_2. The chloracetate is $C_2Cl_3HO_2$, instead of C_2Cl_6, $C_2O_3H_2O$. The molecule of benzoil chloride is C_7H_5OCl, instead of one corresponding to $(C_7H_5)_2O_3$, $C_7H_5Cl_3$, and chlorosulphuric acid is Cl_2SO_2, instead of $2SO_3$, SCl_6.

In proportion as chemists came to know more of the constitution of molecules, and to study chemical reactions from the point of view of the changes which they bring about in the constitution of molecules, did the idea of substitution come to be more and more used in the place of that of mere additive combination. A vast number of processes of chemical combination, which had been considered as consisting of direct combination, were found to be processes of double decomposition.

One of the most important facts which was brought to light by the careful examination of the composition of salts and organic bodies, aided by the molecular method of representing their constitution, was that hydrogen is chemically one of the metals, and that the compounds formed by the combination of water with acids are analogous to other salts of those acids; while compounds of hydrogen with elements or radicals like chlorine are salts, analogous in their constitution to other chlorides, &c.

The molecular or unitary mode of viewing the constitution of each substance affords more *true* as well as more simple records of the facts observed in chemical reactions than could be obtained in the dualistic systems. A salt such as hydric sulphate used to be considered as containing sulphuric acid and water, and represented by a formula such as SO_3, H_2O, implying the presence in it of both the substances from which it was known to be formed.

When two elements combined, their product was considered and described as containing the elementary atoms which had served to form it, and it was consistent with this habit to represent a product which had been formed by the combination of two compound molecules as containing those molecules.

But the main business of chemical investigation is to observe accurately the changes of composition which take place in the reactions of known substances, with a view of discovering the atomic changes to which they are due.

The compound formed by the combination of sulphuric acid and water differs in many physical and chemical properties from both of those bodies. Its name and its atomic formula serve to denote the aggregate of properties which are known to belong to it, whereas the dualistic formula, SO_3, H_2O, served to recall the properties of the acid and base from which it was formed, rather than those of the compound itself.

Elementary chemical reactions which according to the binary mode of viewing compounds were supposed to consist of dualistic processes, involving sometimes the assumption of forces (like predisposing affinity) of a purely metaphysical character, were now explained as consisting of atomic displacements, or interchanges of a kind well known to be of common occurrence. Thus the evolution of hydrogen by the action of zinc or aqueous hydric sulphate was supposed to be the result of a decomposition of water by the metal, such decomposition being induced by the presence of the acid (SO_3), which exerted a predisposing affinity for the zinc oxide. Our present explanation is a simple statement of the fact that, under the conditions described, zinc displaces hydrogen from its sulphate.

The recognition and study of the metallic functions of hydrogen enabled chemists to obtain far clearer and simpler views of the constitution of salts, and to observe the differences of property which are produced in them by the replacement of one element by another. It enabled us to see more and more clearly the characteristic functions of each element, by comparing the constitution and properties of salts containing it with those of the corresponding salts containing other elements.

Thus in the dualistic system we had for the three common phosphates, PO_4NA_3, PO_4Na_2H, PO_4NaH_2, molecular formulæ in which sodium was represented with twice as great an atomic weight as that which we attribute to it, and which in our atomic weights may be thus represented, viz., P_2O_5, $3Na_2O$; P_2O_5, 2Na, O; P_2O_5, Na_2O. In like manner we had such a formula as P_2O_3, $2Na_2O$ (for the phosphite PO_3Na_2H), and for the hypophosphite PO_2NaH_2 we had a formula corresponding to P_2O, Na_2O.

Determinations of water of crystallisation and of chemically combined water proved that many of the compounds assumed on the dualistic system to exist are either not obtainable or have very different properties and a different constitution from those which have been described. Thus we now know that the salts PO_4Na_2H, PO_4NaH_2, PO_3Na_2H, and PO_2NaH_2 cannot be deprived of the elements of water without undergoing a fundamental change of composition and of properties.

The atomic weights of the alkali metals and of silver were found to be half of those of the dualistic system, and an atom of one of these metals, in common double decompositions between their salts and hydrogen salts, changes place with one atom of hydrogen.

Many products of the combination of known molecules were found to be formed by processes of double decomposition, so that each molecule of such products is built up partly of atoms derived from one of the materials, partly of atoms from the other. Thus potassic hydrate is formed by the combination of a molecule of potash with one of water. Yet each molecule of the hydrate is built up of half a molecule of potash and half a molecule of water.

The study of organic compounds played an important part in the improvement of our processes of reasoning. Many of their molecules having a very complex structure were found to undergo in most of their reactions very simple changes, of the same kind as those which mineral compounds undergo. Most of the elements of each organic molecule remained combined together with functions analogous to those of hydrogen or chlorine.

The theory of radicals which had been suggested by the reactions of ammonia-salts and of cyanides was largely extended in organic chemistry.

Many families of organic compounds were discovered, in each of which the members are connected by close analogy of constitution and of properties. Each of these families forms what is called a homologous series, each term of the series being a compound of which the molecule contains one atom of carbon and two atoms of hydrogen more than the previous term.

Thus a series of compounds was proved to have reactions similar to those of common alcohol, and molecular weights ranging from 32 to 438. The lower terms of the series are distinguished from one another by differences of boiling-points approximately proportional to the number of atoms of carbon and hydrogen by which they differ from one another; whilst the higher terms undergo decomposition at the higher temperatures required for their evaporation, and are distinguished from one another by differences of melting-points, that of the alcohol, $C_{30}H_{62}O$, being about 85° C. In their constitution these alcohols were found to be analogous to the alkaline hydrates.

In like manner various other series of alcohols were discovered corresponding respectively in their constitutions to other classes of metallic hydrates. Series were also found of which the members present analogies of reaction with monobasic, bibasic, tribasic hydrogen salts respectively.

These and many other such discoveries were made under the guidance of the atomic theory, developed to the point of systematically recognising and studying the mutual reaction of molecules.

One of the most remarkable and important extensions which our knowledge of molecules has undergone consisted in the discovery that various elements in what we are accustomed to consider the free state, really consist

of molecules containing like atoms combined with one another.

Thus chemists adopt the formulæ O_2, H_2, Cl_2, P_4, J_2, As_4, to denote molecules of the respective elements, and we have for these molecular formulæ evidences of the same kinds as those which serve to establish the molecular formulæ ClH, H_2O, NH_3, &c. In all the best-known reactions in which chlorine and hydrogen are either taken up or evolved we find that those elements behave as chemical compounds of two like atoms; and, moreover, their molecules, as determined from a study of their reactions, have the same volume as that of every compound molecule proved to evaporate without decomposition.

With this knowledge of the molecular constitution of hydrogen and of chlorine gases, we come to regard the direct formation of hydric chloride as due to a process of double decomposition between two molecules, like the reaction of chlorine on an equal volume of marsh-gas.

Many other reactions, such as the evolution of hydrogen by the action of zinc on a hydrogen salt, the liberation of chlorine and nitrogen on the explosive decomposition of their compound, the direct combination of oxygen and hydrogen, we may expect to be able to resolve into mere processes of double decomposition.

The earliest determinations of combining proportions were made with salts (hydrogen salts and others) which undergo double decomposition by mutual contact, and the term equivalent was subsequently introduced to indicate the proportional weights of analogous substances found to be of equal value in their chemical effects. Tables of equivalent weights of acids consisted of numbers standing to one another in the same proportions as the weights of the respective substances found to be of equal value in neutralising a fixed quantity of a particular base; and in like manner tables of the equivalent weights of bases recorded the proportions by weight in which certain bases might replace one another in the neutralisations of a particular quantity of a given acid. Similar determinations have been tabulated of the so-called equivalent weights of elements. Under the dualistic system chemists paid little attention to the essential difference between atomic weights and equivalent weights; and some were of opinion that the facts of chemistry might be represented as consistently from the point of view of equivalence as from that of atoms, and that the idea of atoms (which they considered to be hypothetical) might be dispensed with.

In the system of atomic weights employed under that system, two atoms of hydrogen were generally represented as reacting together, and the symbol of the double atom was marked thus, $\overline{H}\overline{H}$. The alkali metals and silver were represented as having atomic weights twice as great as those which we now adopt, and equivalent to those of the magnesian metals and of oxygen. In a great number of the common reactions of these elements the atomic symbols were consistently used as equivalent symbols. But those who professed to dispense with the atomic theory used atomic symbols, even in cases where they did not represent equivalent weights. Thus nitrogen was always represented by its atomic symbol, and the composition and reactions of nitrogen compounds were always studied and represented in accordance with the atomic theory, using various multiple proportions of what they were still pleased to call equivalent weights, using molecular weights, and various other ideas which formed part of the atomic theory, and which had no known connection with the notion of fixed equivalence. If, however, it be true that all chemical compounds consist of elementary atoms, and that the explanation of chemical reactions consists in stating more and more precisely the changes of combination between the constituent atoms of the reacting molecules; equivalence could only be said to exist between a like number of atoms when they were known to have similar functions. It became necessary to study the relation of equivalence between elementary atoms, instead of studying them from the point of view of elements divisible in any proportion.

It is worth while noticing the general process by which this intellectual change was brought about; for there is a good deal yet to be done in the matter, and our future progress may be guided by experience gained in the past.

It was essentially one-sided. One consideration was brought into very prominent relief, and it threw a marvellous light on the matter. It gave us a clear view of the natural order among elements; but, like every other strong light, it fell on one side only.

The equality of vapour-volumes had been used with great advantage in conjunction with chemical reactions and other evidence as a characteristic of molecules, and the attention of chemists was greatly arrested by the consideration of four typical compounds, which upon the concurrent evidence of very extensive chemical examination and equality of vapour-volumes were known to have respectively a composition corresponding to the formulæ, ClH, OH_2, NH_3, CH_4.

It was known that the atom of oxygen in water can be replaced by chlorine, but that two atoms of chlorine are needed for the purpose. The atom of nitrogen in ammonia requires three atoms of chlorine to replace it, whilst in marsh-gas the atom of carbon is replaceable by four atoms of chlorine. Other elements were studied from the point of view of their respective resemblance to these, and arranged in classes, each of which consisted of atoms equivalent to one another. Thus chlorine, bromine, iodine, fluorine, hydrogen, potassium, sodium, lithium, silver, &c., constituted a class of atoms of equal value, and were called monads. Oxygen, sulphur, selenium, tellurium, calcium, strontium, barium, magnesium, zinc, cadmium, mercury, lead, copper, &c., were classed together as dyads, having equal value amongst themselves, but double the atomic value of the members of the first class. So nitrogen, phosphorus, arsenic, antimony, bismuth, with boron, and some other elements, were considered as forming a class of atoms each of which has three times the value of the monads. The class of tetrads contained carbon, silicon, tin, platinum, &c.

Many apparent exceptions to these atomic values were satisfactorily explained as due to the partial combination of like atoms with one another. Thus in the vast majority of hydrocarbons, such as C_2H_6, C_2H_4, C_2H_2, &c., the atoms of carbon do not appear to the tetravalent, inasmuch as each of the molecules contains less than four atoms of hydrogen to every one atom of carbon. It was well known, however, that polyvalent atoms can combine partly with one element, partly with another, and also that like atoms can combine with one another. Why then should not two tetravalent atoms like carbon combine respectively with three atoms of a monad, and also combine with one another? The compound must be a single molecule with the properties known to belong to methyle, C_2H_6. Again, if this molecule were deprived of two of its atoms of hydrogen, each of the atoms of carbon must combine further with the other atom of carbon forming H_2CCH_2; and a further step in this same direction would give us acetylene, HCCH, in which each atom of carbon is combined with the other to the extent of three-quarters of its value, and with one atom of hydrogen. An extension of this reasoning led to the discovery of long chains of atoms of carbon, each atom forming a link, and each of them (short of the ends) being combined with two other atoms of carbon, while its saturation is completed by hydrogen.

Similar partial combinations of like atoms with one another were recognised in many other classes of compounds, and there is strong reason to expect that the application of the principle will be far more widely extended in proportion as our knowledge of the silicates and other complex classes of compounds becomes somewhat definite.

This incorporation of the doctrine of equivalence into the atomic theory by the division of the elements into classes consisting respectively of equivalent atoms, was probably one of the most important general steps as yet

made in the development of the atomic theory. It was seen to correspond in so clear and striking a manner with a vast number of well known properties and reactions of compounds as to deserve and acquire the confident trust of chemists. But, as often happens in such cases, this confidence in the result carried many of them too far. It led them to assume that atomic values in all other chemical compounds must be always the same as in the compounds under consideration. They saw that they had got hold of the truth, and they thought it was the whole truth. For instance, one most distinguished chemist assumed that each elementary atom has only one value in its compounds; that the atom of nitrogen has always the value three, as in ammonia and its products of substitution, and that in sal ammoniac the atom of nitrogen is chemically combined only with three atoms of hydrogen, whilst the molecule of ammonia is in a state of molecular combination with hydric chloride. Another most distinguished chemist admitted that nitrogen and phosphorus have two atomic values, but not more than two. He held that the respective combining powers are always satisfied by the same number of atoms, no matter what the character of the uniting atoms may be.

With respect to these views it may be noticed that the assumption of combination between molecules as due to some other force than that which binds together the constituents of each molecule—in fact the assumption of molecular combination as an unknown something different from chemical combination, is open to even more grave objections than those which led us to abandon the dualistic system.

To represent a molecule of sal ammoniac as a compound containing two molecules, each one built up by the chemical combination of the constituent atoms, and the two united together by some other force called molecular, was hardly a step in advance of the view which represented it as containing two molecules united together by the same kind of force as that which holds together the atoms in each of the constituent molecules.

The other form of the theory of atomicity as an inherent property of each atom enabling it to combine with an equal number of other atoms, whatever the character of those other atoms may be, seems difficult to reconcile with such facts as the following:—An atom of nitrogen is not known to combine with more than three atoms of hydrogen alone, or of substances like hydrogen, but it forms stable compounds with five atoms (as in the ammonia salts), when four of them are basylous and one of them is chlorous. An atom of sulphur is not known to combine with more than two atoms of hydrogen alone, but it forms stable compounds with four atoms, if three of them are like hydrogen, while the fourth is chlorous. Instances like these are plentiful, and they lead us to look to the chemical characters of the atoms bound together in one molecule as a fundamental condition of the atomic value of the element which binds them together.

Theoretical limitations of natural forces are very difficult of proof, and it is well to be slow and cautious in adopting any such limitation.

A careful consideration of the facts of the case has led me not only to doubt the validity of the supposed limits of atomic value, but to doubt whether we have grounds for assigning any limits whatever to such values.

Atomic values appear to me to be in their very nature variable quantities, and I venture to think that chemistry will be greatly advanced by a full and careful study of the conditions of variation of atomic values.

Two conditions of change of atomic value are particularly worthy of notice:—

I. Temperature.

II. The chemical character of the uniting atoms.

Atomic values increase with fall of temperature, and diminish with rise of temperature. An atom which is combined with as many basylous monads as it can take up by themselves, will take up chlorous monads, or both chlorous and basylous, and reciprocally.

In illustration of the diminution of atomic values with rise of temperature, I may adduce the following well-known reactions:—Sal ammoniac containing nitrogen combined with five monads breaks up at a high temperature into ammonia and hydric chloride; and in like manner other ammonia salts decompose by heat forming ammonia or an amide, with trivalent nitrogen. The highest chlorides of phosphorus and of antimony are decomposed by heat into free chlorine and the lower chloride. Potassic fluosilicate is decomposed by heat into silicic and potassic fluorides; and carbonic acid breaks up at high temperatures into a mixture of carbonic oxide and oxygen.

Amongst illustrations of the greater atomic values which elements assume by combining with both chlorous and basylous atoms than with atoms of the one kind only, we may take the following cases:—Platinum is a metal of which the atom has been supposed to be always tetravalent, because it has not been found capable of combining with more than four atoms of chlorine. The common solution formed by aqua regia contains the compound H_2PtCl_6, a perfectly definite and crystallisable hydrogen salt. Chemists are constantly making and using the potassium and ammonium salts, &c., corresponding to it, yet they conceal from themselves the fact that the atom of platinum is directly combined with eight monads by calling the compounds double salts. The atom of silicon in the silico-fluorides such as H_2SiF_6, or K_2SiF_6, is combined with twice as many monads as it can take up of one kind; so boron, in the crystalline salt, $NaBF_4$, has a higher atomic value than in its fluoride, owing to the presence of the atom of sodium.

In like manner the atom of gold in the well-known salt $NaAuCl_4$, has a higher value than it can assume with chlorine alone.

Sulphur, of which the atom does not combine with more than two atoms of hydrogen, forms with three atoms of methyle, or ethyle, and one atom of iodine, or chlorine, &c., the well-known compounds like $JSMe_3$; and iodine, which is considered a monad, forms the crystalline and stable periodate, $OJ(OH)_5$, and the various metallic derivatives, such as—

$$OJ\begin{matrix}ONa\\(OH)_4\end{matrix} \qquad OJ\begin{matrix}(ONa)_2\\(OH)_3\end{matrix} \qquad OJ(OAg)_5$$

The crystalline compound of the perchlorate with water $(HClO_4 2H_2O)$ has probably a similar constitution. Chemical journals abound with descriptions of definite and well-characterised compounds, which have, like the above, been put aside by the atomicity theory, as mere molecular compounds. The following formulæ are taken almost at random, in illustration of the generality of atomic values far beyond those acknowledged by the theory of atomicity:—

$JPCl_6$	K_2FeF_4	K_2SnCl_6
$KAsF_6$	$2(K_2FeCl_5)$	$KHgJ_3$
K_2AsF_7	$2(K_3FeF_6)$	$K_2HgJ_4 4H_2O$
$KSbF_6$	K_2CuCl_4	$KHgCl_3$
K_2SbCl_5	K_2CuF_4	K_2HgCl_4
K_2SbF_7	$KMgCl_3$	
K_2BiCl_5	K_2MgBr_4	
K_2AgJ_3		

I have for convenience written in the middle of each of these formulæ the symbol of the atom which I assume to act as connecting element. If we consider the atomic values usually found in these elements, together with those represented by the above list, we see that their atomic values vary according to the numbers given in a line with them respectively in the following table. It has yet to be proved that the atom of platinum is tetravalent in any known compound, for there is no sufficient evidence to show that platinic chloride has a molecular weight corresponding to the formula $PtCl_4$, instead of one corresponding to Pt_2Cl_8, each atom of platinum being partly combined with the other, partly with chlorine.

Atomic Symbols.	Atomic Values.
C	2, 4
S	2, 4
Pt	4 (?), 8
Si	4, 8
Sn	4, 8
Cu	2, 6
Hg	2, 4, 6
Mg	2, 4, 6
Ag	1, 5
B	3, 5
J	1, 7
N	3, 5
P	3, 5, 7
As	3, 7, 9
Sb	3, 5, 7, 9
Bi	3, 7
Au	3 (?), 5

Not only are there elements of which an atom is found in combination with a greater number of basylous and chlorous monads together than of either kind alone, but there are also elements which are not known to form chemical compounds with hydrogen or potassium alone, and yet which combine with either of them when also combined with chlorine, fluorine, &c. This is illustrated by the following compounds, viz., $HAuCl_4$, H_2PtCl_6, $NaBF_4$, K_2SiF_6, K_2FeF_4, K_2CuCl_4. It is also well known that there are many cases of elements of which an atom cannot combine with as many monads of one kind as of another. For instance an atom of nitrogen or of antimony is only known to be trivalent in combination with hydrogen; but each of them occurs in the form of a pentavalent compound with chlorine. Antimony forms either no compound with five atoms of bromine, or a compound more unstable than the higher chloride.

Many more such instances might easily now be given, and a vast number will doubtless be found when the investigations of chemists are directed to the search of them. I have only given these few by way of illustration of the leading conditions of change of atomic values.

In the course of their investigations of the precise interchanges of atoms which take place between molecules, chemists were frequently led to observe evidences of the order in which the constituent elements are combined; and with the more wide and accurate knowledge of reactions which is now in their possession, they have been enabled to follow up so far the study of the respective state of combination of each atom in a molecule as to arrive at simple and consistent explanations of facts which had previously eluded the grasp of science.

Our knowledge of the order of combination of atoms in a molecule and of the differences between direct and indirect combinations of particular atoms may be said to have originated chiefly in the study of the compounds of nitrogen. Thus it was found that the hydrogen in ammonia differs in many of its chemical functions from hydrogen in hydrocarbons. A base (called methylia) was discovered having a molecular composition corresponding to the empirical formula (CNH_5), and this base was found to contain two atoms of hydrogen like those of ammonia, and three atoms like those in hydrocarbons. Its constitution was accordingly represented by a formula describing it as an ammonia, in which one atom of hydrogen is replaced by the monad methyle, or, to be more explicit, as containing two atoms of hydrogen directly combined with nitrogen, and three atoms of hydrogen indirectly combined with that same atom of nitrogen through the intervening atom of carbon. Writing in juxtaposition to one another the symbols of those atoms which are directly combined, we can express the facts by the following formula, viz., H_2NCH_3.

Those marvellous varieties of matter called isomeric compounds found their natural explanation in differences of the respective arrangements of like atoms. Thus two bases were discovered having the same empirical molecular formula, C_2NH_7. One of them is made by different reactions from the other, and in its decompositions differs from the other. All these chemical differences between them are found to be due to the fact that one of them (called ethylia) contains two atoms of hydrogen directly combined with the nitrogen, and the monovalent hydrocarbon ethyle in place of the third atom of hydrogen; whilst the other (called dimethylia) contains only one atom of hydrogen combined directly with nitrogen, the carbon of the two atoms of methyle completing the saturation of the trivalent nitrogen, as expressed by the formula $HN(CH_3)_2$.

It was subsequently proved that an atom of oxygen may combine with two like or unlike monads, such monads being indirectly combined with one another through the intervening atom of oxygen. Thus five of the atoms of hydrogen in common alcohol were proved to be in direct combination with the carbon, whilst the other one is indirectly combined with it through the oxygen, as expressed by the formula $HO(C_2H_5)$.

Another compound (called methyl-oxide) was proved to have the same empirical composition, but very different properties and reactions, its constitution being explained by the formula H_3COCH_3.

Again, two compounds of distinct reactions and properties were found to have the same empirical molecular composition, C_2NH_3, and it was clearly proved that in one of them the two atoms of carbon are directly combined thus, $NCCH_3$, whilst in the other they are indirectly combined through the atom of nitrogen, $CNCH_3$.

An immense amount of admirable work has been done of late years (especially in Germany) in working out the evidences of the atomic order of complex organic bodies, and in thereby obtaining a command of their reactions.

Evidences of the same kind have been obtained of the atomic arrangement of some few of the simplest inorganic bodies, and it is to be hoped that ere long chemists will recognise the importance of examining the constitution of salts with the aid of the principles established in organic chemistry.

The foundation is already laid by our knowledge of the constitution of such compounds as—

$$HOH,\ HOK,\ HONH_4,\ HONO_2$$
$$HOPbOH,\ HOPbONO_2,\ HOCOK,\ HOSOH$$
$$O \qquad O_2$$

and there is a strong probability regarding the atomic constitution of many other water compounds, *e.g.*,—

$$SO_4H_2+H_2O=OS(OH_2)_4, SO_5H_4+H_2O=S(OH)_6.$$

Amongst the extensions of our means of examining the physical properties of matter, and thereby discovering new varieties of matter for chemical investigation, spectrum analysis has played an important part, and is no doubt destined to do far more. It has already led chemists to the discovery of several previously unknown elements, and has led to the detection of various known elements in distant masses of which we had previously no chemical knowledge.

Up to this point the growth of the atomic theory will be seen, from the general outline which I have endeavoured to trace, to have consisted mainly in the more and more full and exact identification of each elementary atom, and in the accumulation of more and more varied and accurate evidences of its functions in relation to other atoms. A step was made towards a knowledge of the general relations of atoms to one another by their preliminary classification according to their best-known values.

But a far greater step has been more recently made, one which is evidently destined to lead to most important results.

It was discovered that if we arrange the elements in the empirical order of their respective atomic weights, beginning with hydrogen and proceeding thence step by step to the heaviest atom, we have before us a natural series with periodically recurrent changes in the chemical and physical functions of its members.

Of course the series is imperfect, and exhibits gaps and

irregularities; but what view of natural order was complete in its infancy?

Some of the gaps have already been filled up by the discovery of elements possessing the anticipated properties. The generalisation affords a brilliant addition to the previous corroborations of the reality of the units of matter which chemists have discovered.

Chemists have as yet taken but little account of atomic motions; although the most perfect explanation of a chemical reaction consists of a statement of the atomic interchange which takes place between two molecules; or the change of mutual combination between the atoms in one molecule.

It has, however, been proved that the heat of combination affords a measure of its force; and we know that in giving off heat particles of matter undergo a diminution of velocity of motion. We see, accordingly, that substances capably of exerting great force by their combination are those which can undergo a great diminution of the velocity of their internal motions, and reciprocally.

The force of chemical combination is evidently a function of atomic motion.

It has been shown that the relative velocities of certain atomic interchanges afford a measure of the amount of chemical action between two substances; but a vast amount of work will doubtless be required to develop the atomic theory to the point of explaining the force of chemical action in precise terms of atomic motion.

The general terms of chemistry are mere symbols. Each of them serves to recall a group (usually a very large group) of facts established by observation. The explanation of each term is afforded by a careful study of the facts which it is used to denote; and, accordingly, a chain of evidence involving the use of chemical terms can be fully understood only by chemists accustomed to the consideration of such evidence. The general outline of it may perhaps be to some general thinkers of sufficient interest to attract them to further study of our science.

ESTIMATION OF POTASSIUM AS PLATINUM SALT.

By DAVID LINDO.

(Concluded from p. 98.)

On the Solubility of Platino-potassic Chloride.

The question as to the amount of loss sustained by washing through the solvent action of alcohol or spirit of wine on the precipitate had often occurred to me in the course of this enquiry.

The solubility of platino-potassic chloride has been very variously stated by different authors. Fresenius in his latest edition of "Quantitative Analysis" gives it as—

1 part in 12083 absolute alcohol.
" 3775 spirit of wine, 76 per cent.
" 1053 spirit of wine, 55 "

Dr. Precht (Chemical News, vol. xli., p. 11)—

1 part in 42600 absolute alcohol.
" 37300 spirit of wine, 96 per cent.
" 26400 spirit of wine, 80 "

Not having seen the original paper by Precht, I am uninformed as to the manner in which the experiments were conducted. It does not appear that any experiments have been made by Fresenius later than those adduced in support of his statements in the older editions of his work on Quantitative Analysis. On reference to these it will be found the condition of the salt—whether it was in crystals or in the pulverulent state—is not mentioned. The digestion in the menstruum was continued for six days with frequent agitation. It does not appear that shorter or onger periods of digestion were tried as a control to the results obtained in these experiments. It is probable that in the case of a substance so sparingly soluble, very prolonged contact with the solvent—at least at ordinary temperatures—will be required in order to reach the point of saturation. Be that as it may, a digestion of six days in alcohol or spirit of wine is not resorted to in analysis for the purpose of washing the precipitate: therefore, these experiments, however valuable they may be for the purpose of ascertaining the absolute solubility of the salt, will not exactly serve the needs of the present enquiry, the purpose of which is to ascertain as *nearly as possible* the loss sustained by washing the precipitate.

That we can only estimate this approximately is sufficiently obvious. The plan adopted in the experiments that follow (which of course were made while the other work was going on) was to submit the precipitates obtained in the analyses (after the latter were concluded and the results recorded) to a further washing with the fluids, the solvent action of which was to be tested. The precipitates were then dried again at 130° C., and weighed again. Before the precipitates were submitted to this treatment the weights were always verified. The pressure employed was the same as I used for filtering in the analyses, and equal to about 14 inches of mercury. The temperature of the laboratory during the experiments ranged from 26° to 30° C. The same balance was used as I employed in all my other experiments. It is a very fine Oertling, and marks 0·0001 grm. distinctly. The method of weighing has been already described. I have not placed the experiments in the order in which they were made, but grouped them together more in accordance with what they are intended to illustrate.

Every care was taken in making these experiments, yet where such small differences of weight have to be noted some allowance must be made for occasional slight observational errors. I am quite confident, however, that if the experiments to be described are repeated by others with care, the results on the whole will be found to agree with those I have recorded.

Abbreviations Employed.

S.W.—Spirit of wine 80 per cent.
Alcohol.—98 per cent strength.
D. and W.—Dried at 130° and weighed.
Pre.—Precipitate from.
Expt.—Experiment.
Passed.—Allowed the fluid to run through the precipitate under pressure of the filter-pump.

The per cent return which the precipitate selected for experiment had yielded, and its condition, whether in scales or powder, will be stated.

No. 1.—Pre. Expt. 14. Weight 0·8812. Scales. 99·89 per cent. Passed 100 c.c. S.W. D. and W. Loss, 0·0009. Passed 100 c.c. alcohol. D. and W. Further loss, 0·0001. Passed a fresh 100 c.c. alcohol. D. and W. Further loss, 0·0001.

No. 2.—Pre. Expt. 94. Weight 1·5386. Scales. 99·90 per cent. Passed 20 c.c. alcohol five times. D. and W. No loss.

No. 3.—Pre. Expt. 95. Weight 1·6624. Scales. 99·87 per cent. Passed 20 c.c. alcohol five times. D. and W. No loss.

No. 4.—Pre. Expt. 98. Weight 1·4760. Scales. 99·68 per cent. Passed 100 c.c. alcohol *five times*. D. and W. Loss, 0·0001.

No. 5.—Pre. Expt. 102. Weight 1·9260. Scales. 99·85 per cent. Passed 100 c.c. alcohol *five times*. D. and W. Loss, 0·0002.

No. 6.—Pre. Expt. 100. Weight 1·7800. Scales. 99·83 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0004.

No. 7.—Pre. Expt. 101. Weight 1·7495. Scales. 99·70 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0003.

These two last precipitates (obtained by Tatlock's method) had been digested in a very strong solution of platinic

chloride, from which they do not appear to have been quite free.

No. 8.—Pre. Expt. 44. Weight 0·9359. Powder. 99·93 per cent (?). Passed 100 c.c. S.W. D. and W. Loss, 0·0028. Passed 100 c.c. alcohol. D. and W. Further loss, 0·0002.

No. 9.—Pre. Expt. 45. Weight 0·9656. Powder. 100·08 per cent (?). Passed 100 c.c. S.W. D. and W. Loss, 0·0034. Passed 100 c.c. alcohol. D. and W. Further loss, 0·0002.

No. 10.—Pre. Expt. 57. Weight 0·9491. Powder. 99·90 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0001. Passed 20 c.c. S.W. five times. D. and W. Further loss, 0·0004.

No. 11.—Pre. Expt. 61. Weight 0·9252. Powder. 99·96 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0002. Passed 20 c.c. S.W. five times. D. and W. Further loss, 0·0008.

No. 12.—Pre. Expt. 62. Weight 0·8059. Powder. 100 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0003. Passed 20 c.c. S.W. five times. D. and W. Further loss, 0·0008.

No. 13.—Pre. Expt. 63. Weight 0·8142. Powder. 100·03 per cent. Passed 20 c.c. alcohol five times. D. and W. No loss. Passed 20 c.c. S.W. five times. D. and W. Loss, 0·0005.

No. 14.—Pre. Expt. 70. Weight, 1·0188. Powder. 99·89 per cent. Passed 20 c.c. alcohol five times. D. and W. No loss. Passed 20 c.c. S.W. five times. D. and W. Loss, 0·0005.

From these results we may conclude—

(1) That when the precipitate (whether in scales or powder) is washed with absolute or very strong alcohol there will be practically no loss, and therefore that we need not be *afraid* to wash it.

(2) That when it is in scales and washed with 80 per cent spirit of wine there will be a small loss.

(3) That when it is in powder and washed with 80 per cent spirit, the loss may be sufficient to affect the results sensibly.*

It will be noticed that the precipitates selected for the above experiments were such as, from the results of the analyses that had yielded them, might be considered pure or very nearly so. A few experiments on precipitates from analyses that had yielded high results will now be described.

No. 15.—Pre. Expt. 52. Weight 0·7966. Scales. 100·19 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0014. Passed a fresh 20 c.c. alcohol five times. D. and W. Further loss 0·0002.

First washing reduced weight to 0·7952 = 0·24301 KCl, against 0·24298 taken.

No. 16.—Pre. Expt. 53. Weight 0·8496. Scales. 100·12 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0014. Passed a fresh 20 c.c. alcohol five times. D. and W. Further loss, 0·0002.

First washing reduced weight to 0·8482 = 0·25921 KCl, against 0·25932 taken.

It is pretty evident that the impurities in these precipitates had been retained by surface adhesion, although in the *analyses* the alcohol that had been used to wash with measured 59 c.c. in Expt. 52 and 62 c.c. in Expt. 53.

No. 17.—Pre. Expt. 54. Weight 0·7797. Scales. 100·22 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0007.

No. 18.—Pre. Expt. 60. Weight 0·8149. Powder. 100·12 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0005. Passed a fresh 20 c.c. alcohol five times. D. and W. Further loss, 0·0002.

No. 19.—Pre. Expt. 81. Weight 0·6884. Powder. 100·12 per cent. Passed 20 c.c. alcohol five times. D. and W. Loss, 0·0006.

* Having abandoned the use of dilute alcohol for washing the precipitate, I have not gone into the necessary calculations for ascertaining the correction required when this fluid is employed. A larger number of experiments than the above would be required to arrive at this even approximately.

Notes.

So far, my experiments have been confined to the estimation of K when in the state of pure chloride, or in mixtures of pure chlorides of K and Na. As regards its estimation in sulphate of potassium, if sufficient HCl and platinic chloride are employed, the reaction—

$$K_2SO_4 + 2HCl + PtCl_4 = K_2PtCl_6 + H_2SO_4$$

may be expected to occur. If the reaction is complete there will be nothing to remove from the precipitate that alcohol is not capable of dissolving, and resort to aqueous fluids in washing is therefore unnecessary. If the reaction is not complete, of course we cannot obtain accurate results, however we may wash. With an aqueous fluid we should lose a portion of potassium as sulphate, and if alcohol alone were used we should be weighing a portion of K as sulphate, and calculating it as chloro-platinate.

Nitrate of potassium may be converted into KCl by repeated evaporation with HCl, but I quite agree with the Committee that it is difficult to complete the reaction. In one experiment, seven evaporations on the water-bath with excess of strong HCl proved insufficient to effect complete conversion. If NaCl and $PtCl_4$ are employed—as suggested by the Committee—to produce the reaction $2KNO_3 + 2NaCl + PtCl_4 = K_2PtCl_6 + 2NaNO_3$, nitrate of sodium has to be removed from the precipitate, and alcohol of course will not remove it.

Commercial potassium salts often contain sulphate of magnesium and sulphate of sodium. If the former is mixed with HCl and excess of $PtCl_4$, and evaporated nearly to dryness, magnesium chloro-platinate may be formed; but although this salt is largely soluble in alcohol, on adding that fluid a precipitate subsides, either immediately or after a time, being sulphate of magnesium which has partially or completely re-formed. There is little doubt but that the same thing would occur with sulphate of sodium.

Unless we can find a fluid that will dissolve out these sulphates without acting on the chloro-platinate of potassium, we must—as is generally admitted—either remove the sulphuric acid before precipitating the potassium if we wish to weigh as platinum salt, or reduce in hydrogen and weigh the platinum.

I have found that the chloro-platinate of potassium is very sparingly soluble in solutions of certain salts, remarkably so in a solution of chloride of ammonium.

My experiments as yet have been principally confined to a solution of chloride of ammonium about half saturated, made by saturating distilled water with the salt at ordinary temperature, and mixing this with an equal volume of water. If the chloro-platinate is even boiled in this solution it imparts no colour to it—or practically none—unless the boiling is continued for a long time, say one to two hours, when a faint yellow tinge is observed. Probably by this protracted boiling slight decomposition takes place.

In order to estimate roughly the solubility of the chloro-platinate in this solution, I made a saturated aqueous solution of the platinum salt first, and evaporated a weighed portion in a platinum dish to dryness on the water-bath. The residue was then moistened with alcohol, again evaporated to dryness, and weighed. It was thus found that 83 parts of this aqueous solution contained one part of the chloro-platinate. Small portions of this solution were then weighed in a beaker, and 10 c.c. of the solution of the chloride of ammonium added in each case. The mixture was then transferred to a test-tube and shaken up. It was found that when a quantity of the aqueous solution of chloro-platinate equal to about 0·001 grm. of the salt was added to 10 c.c. of NH_4Cl solution no preci-

pitate formed, even after standing several hours; but when about 0·002 grm. of chloro-platinum was added to 10 c.c. of NH_4Cl solution, a precipitate, plainly visible with a lens, formed in a few seconds.

The quantity of chloro-platinate which 10 c.c. of NH_4Cl solution of the strength employed can hold in solution may therefore be roughly stated as 0·0015 grm.

It was thought this solution of NH_4Cl might be rendered available for the purpose of washing the sulphates and nitrates out of the precipitate in the analysis of commercial potassium salts by the platinum method. With ordinary care and attention to cleanliness there would be no risk in using it.

It was intended to use about 20 c.c. of the solution in each analysis, and to pass this several times through the precipitate If the solution thus became saturated with chloro-platinate, a loss of about 0·003 grm. would occur, affecting the results sensibly.

But it is very easy to avoid this loss by saturating the NH_4Cl solution previous to using it in the analyses with the minute quantity of chloro-platinate which it is capable of dissolving. This may be effected by adding some of the chloro-platinate to the solution of NH_4Cl, and heating with frequent stirring just to boiling; or if the solution is not immediately required for use, by keeping a small quantity of the chloro-platinate in scales in the bottle containing the NH_4Cl solution, and shaking occasionally. In either case it is advisable to keep some of the platinum salt in the bottle containing the solution, and filter a portion of the latter as required for use.

The time at my disposal for trying chemical experiments being very limited, I have only been able as yet to make ten estimates by this method. The KCl was mixed with 25 per cent of sulphate of magnesium (crystals) and 10 per cent of chloride of sodium.

The precipitates in these experiments were not crushed, but they were first *thoroughly* washed with 98 per cent alcohol by running the last washings through five times. The receiver was then changed, and 20 c c, of the NH_4Cl solution prepared as above passed through five times. The alcoholic washings having been removed from the first receiver, this was again placed in position, and 25 c.c. of 80 per cent spirit of wine passed through the precipitate twice. Finished by filling the crucible once or twice with alcohol. The results are given in Table VII.

To those who have never tried it, returning the fluids so often through the precipitates may appear tedious work; in practice, however, it will be found otherwise. When the precipitate is in scales the fluids run through in a continuous stream, and to pass 25 to 30 c.c. five times scarcely occupies five minutes. The pump is kept in action all the time, and the short piece of indiarubber tubing that connects with the glass tube from the receiver is slipped off and on for the purpose of removing the filtrate and renewing connection afterwards.

The time required for all the manipulations from drenching the precipitate with alcohol after removal from the water-bath to placing it in the drying oven, is thirty or forty minutes. It is necessary to remove the excess of platinic chloride completely from the precipitate by thorough washing with alcohol before applying the NH_4Cl solution, or chloro-platinate of ammonium would be formed, and as this is very sparingly soluble in solution of NH_4Cl, it might not be completely removed by the after washing.

Table VII.

Expts.	KCl taken.	Weight of Precipitate.	KCl Obtained per cent.
104	0·46239	1·5148	100·11
105	0·40955	1·3404	100·02
106	0·42510	1·3920	100·07
107	0·41477	1·3597	100·18
108	0·45149	1·4797	100·16
109	0·48252	1·5805	100·10
110	0·44488	1·4552	99·96
111	0·43679	1·4244	99·66
112	0·43062	1·4050	99·71
113	0·41726	1·3649	99·96
	Average..		99·99

That the results might be sometimes slightly in excess of the truth was to be expected, the precipitates not having been crushed, but with the exception of the washing with spirit of wine after applying the NH_4Cl, I know of nothing in the process, if sufficient platinum is used, that could lead to minus error. The loss by passing 25 c.c. 80-per cent spirit twice through the precipitate in *scales* would be very slight. It is probable the low results obtained in Experiments Nos. 111 and 112 are due to my having been rather sparing of platinum, the solution being nearly finished.

In one experiment at least (No. 113) all the sulphuric acid went out with the alcoholic washings (which nevertheless were quite brilliant), so the washing with solution of NH_4Cl happened in this case to have been superfluous. The same may have occurred in some of the other experiments. That a portion at least of the sulphuric acid (free or in the form of sulphates) had been removed by the strong alcohol was evident, for although the filtrates were very brilliant at first, they became turbid on standing, and deposited sulphates.

Although it appears probable that this method will be found to answer, it must stand the test of a more rigorous examination before it can be pronounced thoroughly reliable. Having little time for this at present, I shall be glad to hear of the experience of others who may think it worth a trial. If the precipitates were crushed, it is probable the slight tendency to high results would cease, returning the filtrates so often would be unnecessary, and a smaller quantity of spirit of wine could be used to wash out the NH_4Cl; but the care and attention required when crushing is resorted to and solution of NH_4Cl employed are greater than those engaged in technical analyses would I fancy be willing to bestow on the process.

Solution of NH_4Cl somewhat weaker than the one I used may be found to answer, but of course it must not be so weak as to be capable of taking up more than traces of the chloro-platinate.

In the *Journal of Science* for June, 1881 (which has just reached me), I see it mentioned under the head of "Notes" that Dr. Seubert has determined the atomic weight of platinum as 194·46124. This would give the factor 0·3073 instead of 0·3056 for converting the chloro-platinate into KCl.

The consequence of employing the former intead of the latter factor is shown in the following statement:—

	Precipitate	×	Factor.	KCl per cent.
Fresenius ..	1·1170	×	0·3056	100·00
Dr. Seubert ..	1·1170	×	0·3073	100·55

If Dr. Seubert's numbers are correct, the only conclusion I can arrive at is that the determination of potassium as platinum salt, although it may perhaps be considered sufficiently accurate for technical purposes, will certainly not satisfy the requirements of scientific exactness.

The very sensible error in excess, which nearly all the analyses I have given would show if the new atomic weight for platinum were adopted, would be due either to the presence of impurities, which no amount of washing can remove, or the retention of moisture, which could only be expelled at a temperature at which the salt would suffer decomposition.

Concluding Remarks.

For those who may not have seen the paper by Gooch, describing his method, I may state—

(1.) The holes in the bottom of the crucible should be small and numerous.

(2.) The fibre of the asbestos must be silky. It is scraped to down with a penknife, boiled in HCl. Washed thoroughly with distilled water, and preserved under water for use.

(3.) To form a felting, start the pump, place the crucible in the hole in the indiarubber stopper; connect with pump; stir up the asbestos, and pour a little of the water containing it into the crucible. Do this two or three times if you require the felting thick, then run a little distilled water through to remove loose particles.

(4.) Before taking the tare of crucible and felting, ignite them gently. You need not place them under a desiccator to cool. After weighing, if you were to moisten the asbestos with water, and dry even at no higher temperature than 100° C., on weighing again you would find the weight the same.

In making a large number of potash estimates by this method, the same felting may be used several times, and with the advantage that the filtrates will be obtained very brilliant from the first if the felting has been used even once before.

The precipitate is removed carefully and as completely as possible without disturbing the felting, and the adhering particles are included in the tare for the next experiment.*

I have used feltings in this way repeatedly; there is no risk of impairing the accuracy of the results in the *slightest* degree. If reduction in hydrogen is to be effected, it is better the precipitate should be in scales. Place the Gooch's crucible with the precipitate (and with the cover I have described on) inside a Rose's crucible, turn on the hydrogen, and after a few minutes heat gently. I keep the flame of the lamp about an inch from the bottom of the Rose's crucible. After reduction, wash out the salt with hot water, using the filter pump, and ignite the platinum gently.

I employ Gooch's method in all cases where it is applicable, and find it invaluable.

In estimating mercury as sulphide, it is extremely convenient. I am certain that once having used it in the estimation of potassium as platinum salt, no one from choice will resort to a paper filter for the purpose of separating the precipitate.

Falmouth, Jamaica, B.W.I., June 22, 1881.

NOTICES OF BOOKS.

Townson and Mercer's Catalogue of Chemical Apparatus and Chemicals. Second Edition. 89, Bishopsgate Street Within.

THE present edition of Messrs. Townson and Mercer's catalogue is much extended and includes many pieces of apparatus recently brought into use. We may mention Dr. Skalweit's apparatus for testing petroleum; the appliances devised by Mr. MacIver and by Mr. Sacker for testing lubricating oils; Schwarz's apparatus for determining nitrogen; and Mr. Stephenson's apparatus for the estimation of sulphur in spent oxide.

An appendix describes and figures the exceedingly useful gas-burners, furnaces, &c., devised by Mr. Fletcher, of Warrington.

The catalogue includes not mere chemical apparatus and reagents, but the principal appliances needful for demonstration and research in the various branches of physics.

Many sets of apparatus for special purposes are here described, such as Prof. O. Graham's set for the analysis of malt, beer, &c., Prof. Tuson's selection of apparatus for the students of the Royal Veterinary College, Mr. Wanklyn's set for the use of Medical Officers of Health, the sets for the Royal College, the Pharmaceutical set as arranged by Prof. Attfield, the sets for the Oxford and Cambridge Local Examinations, &c.

* Of course, if the results are to be controlled by reduction in hydrogen, this cannot be done.

Justus von Liebig, His Merits in the Promotion of Practical Medicine. A Memorial Address, Delivered at the Annual Meeting of the Society for the Advancement of the Natural Sciences in Marburg, June 11, 1874. By the Director, Prof. Dr. F. W. BENEKE. Glasgow: James Maclehose, Publisher to the University.

THIS address has been remarkably tardy in making its appearance in our language. By whom it has been translated we are not informed. Almost at the very outset we meet with an assertion, about which we must join issue. Says Prof. Beneke, "What Newton was in the region of Natural Philosophy, Liebig was in the region of Biology." We should certainly be the last to overlook any just claims made on behalf of Liebig, but we cannot assign to him a position which, if due to any man who has yet appeared —a very doubtful question—belongs of right to Charles Darwin! The contributions of Liebig to the chemistry of physiology are of unquestionable value, but in the other great departments of biology, in morphology, embryology, and taxonomy, he played no part at all.

On p. 19 we read:—"it is still customary to give soda, particularly as carbonic acid, &c." This is, as it stands, unintelligible. For "carbonic acid," we must read "carbonate." The translator has mistaken "kohlen-saure," for kohlen-säure."

In referring to Liebig's part in the sanitary reform movement, Dr. Beneke remarks:—"This task," *i.e.*, the preservation of the fruitfulness of land, "cannot, for various reasons, be accomplished by irrigation, and thus we are brought more and more to the avowed conviction that sewage is the very reverse of being the best system for removing excrements from towns.

The pamphlet may fairly be pronounced a "clear and comprehensive epitome of the life-work of Liebig with reference to medical practice and sanitation.

Syllabus of Materia Medica, for the Use of Students, Teachers, and Practitioners, Based on the Relative Values of Articles and Preparation in the British Pharmacopœia. By ALEXANDER HARVEY, M.D., and A. D. DAVIDSON, M.D. Fifth Edition. London: H. K. Lewis.

THIS work, which is of a pocket size, is based, as the authors tells us, on a two-fold principle—first, that of an estimate of the relative values of the articles and preparations in the Pharmacopœia, and secondly, that of a selection of the more important of these. They advocate a restriction of the range at present granted to the examiner who, in Materia Medica, as well as in every other department of medical science, may at present take a perfectly encyclopædic view, and question candidates in the most unimportant things. It must be admitted that the plan adopted in the work before us, though in itself excellent, can be of little practical value until such a limitation is decreed by the proper authorities.

MISCELLANEOUS.

British Association for the Advancement of Science. —The following are the names of the Officers and Committee of Section B (Chemical Science Section) of the York Meeting of the British Association:—

President—Professor A. W. Williamson, Ph.D., F.R.S.

Vice-Presidents—F. A. Abel, C.B., F.R.S.; I. Lowthian Bell, F.R.S.; Professor J. Dewar, M.A., F.R.S.; Professor E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. G. Vernon Harcourt, M.A., F.R.S.; Professor W. Odling, M.B., F.R.S.; Professor H. E. Roscoe, B.A., F.R.S.; Professor T. E. Thorpe, Ph.D., F.R.S.

Secretaries—Harold B. Dixon, M.A.; P. Phillips-Bedson, D.Sc.; T. Gough, B.Sc.

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NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Naphthalen.—I have read the last two articles in the Chemical News, vol. xliv., p.p. 65, 85, on the "Preparation of Pure Naphthalen." Will Mr. W. W. Staveley, or any maker, inform me through the Chemical News, at what price per ton commercial white naphthalen could be produced. Some time back I was experimenting with this article. I bought it at a wholesale chemist's, but the price was so high that I abandoned my experiments. I have since written to two supposed makers, but they answered they had ceased to make it. I particularly want to know if the article could be supplied in bulk, and at about the price per ton?—J. W. T.

TO CORRESPONDENTS.

J. Dunlop.—The old charcoal combustion furnace in use before gas furnaces were introduced would answer your purpose.

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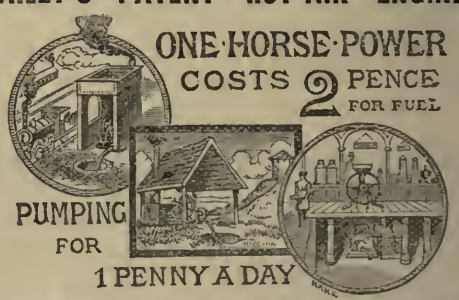

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1138.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

By Sir WILLIAM THOMSON, F.R.S.,
Professor of Natural Philosophy in the University of Glasgow.
President of the Section.

On the Sources of Energy in Nature Available to Man for the Production of Mechanical Effect.

During the fifty years' life of the British Association, the Advancement of Science for which it has lived and worked so well has not been more marked in any department than in one which belongs very decidedly to the Mathematical and Physical Section—the science of Energy. The very name energy, though first used in its present sense by Dr. Thomas Young about the beginning of this century, has only come into use practically after the doctrine which defines it had, during the first half of the British Association's life, been raised from a mere formula of mathematical dynamics to the position it now holds of a principle pervading all nature and guiding the investigator in every field of science.

A little article communicated to the Royal Society of Edinburgh a short time before the commencement of the epoch of energy under the title "On the Sources Available to Man for the Production of Mechanical Effect,"* contained the following:—

"Men can obtain mechanical effect for their own purposes by working mechanically themselves, and directing other animals to work for them, or by using natural heat, the gravitation of descending solid masses, the natural motions of water and air, and the heat, or galvanic currents, or other mechanical effects produced by chemical combination, but in no other way at present known. Hence the stores from which mechanical effect may be drawn by man belong to one or other of the following classes:—

"I. The food of animals.

"II. Natural heat.

"III. Solid matter found in elevated positions.

"IV. The natural motions of water and air.

"V. Natural combustibles (as wood, coal, coal-gas, oils, marsh-gas, diamond, native sulphur, native metals, meteoric iron).

"VI. Artificial combustibles (as smelted or electrically-deposited metals, hydrogen, phosphorus).

"In the present communication, known facts in natural history and physical science, with reference to the sources from which these stores have derived their mechanical energies, are adduced to establish the following general conclusions:—

"1. *Heat radiated from the sun* (sunlight being included in this term) *is the principal source of mechanical effect available to man.*† From it is derived the whole mechanical effect obtained by means of animals working, water-wheels worked by rivers, steam-engines, galvanic engines, windmills, and the sails of ships.

"2. The motions of the earth, moon, and sun, and their mutual attractions, constitute an important source of available mechanical effect. From them all, but chiefly no doubt from the earth's motion of rotation, is derived the mechanical effect of water-wheels driven by the tides.

"3. The other known sources of mechanical effect available to man are either terrestrial—that is, belonging to the earth, and available without the influence of any external body—or meteoric—that is, belonging to bodies deposited on the earth from external space. Terrestrial sources, including mountain quarries and mines, the heat of hot springs, and the combustion of native sulphur, perhaps also the combustion of inorganic native combustibles, are actually used; but the mechanical effect obtained from them is very inconsiderable, compared with that which is obtained from sources belonging to the two classes mentioned above. Meteoric sources, including only the heat of newly-fallen meteoric bodies, and the combustion of meteoric iron, need not be reckoned among those available to man for practical purposes."

Thus we may summarise the natural sources of energy as Tides, Food, Fuel, Wind, and Rain.

Among the practical sources of energy thus exhaustively enumerated, there is only one not derived from sun-heat—that is the tides. Consider it first. I have called it *practical*, because tide-mills exist. But the places where they can work usefully are very rare, and the whole amount of work actually done by them is a drop to the ocean of work done by other motors. A tide of two metres' rise and fall, if we imagine it utilised to the utmost by means of ideal water-wheels doing with perfect economy the whole work of filling and emptying a dock basin in infinitely short times at the moments of high and low water, would give just one metre-ton per square metre of area. This work done four times in the twenty-four hours amounts to 1·1620th of the work of a horse-power. Parenthetically, in explanation, I may say that the French metrical equivalent (to which in all scientific and practical measurements we are irresistibly drawn, notwithstanding a dense barrier of insular prejudice most detrimental to the islanders),—the French metrical equivalent of James Watt's "horse-power" of 550 foot-pounds per second, or 33,000 foot-pounds per minute, or nearly two million foot-pounds per hour, is 75 metre-kilogrammes per second, or 4½ metre-tons per minute, or 270 metre-tons per hour. The French ton of 1000 kilos. used in this reckoning is 0·984 of the British ton.

Returning to the question of utilising tidal energy, we find a dock area of 162,000 square metres (which is little more than 400 metres square) required for 100 horse-power. This, considering the vast costliness of dock construction, is obviously prohibitory of every scheme for economising tidal energy by means of artificial dock-basins, however near to the ideal perfection might be the realised tide-mill, and however convenient and non-wasteful the accumulator—whether Faure's electric accumulator, or other accumulators of energy hitherto invented or to be invented—which might be used to store up the energy yielded by the tide-mill during its short harvests about the times of high and low water, and to give it out when wanted at other times of six hours. There may, however, be a dozen places possible in the world where it could be advantageous to build a sea-wall across the mouth of a natural basin or estuary, and to utilise the tidal energy of filling it and emptying it by means of sluices and water-wheels. But if *so* much could be done, it would in many cases take only a little more to keep the water out altogether, and make fertile land of the whole basin. Thus we are led up to the interesting economical question, whether is forty acres (the British *agricultural* measure for the area of 162,000 square metres) or 100 horse-power more valuable. The annual cost of 100 horse-power night and day, for 365 days of the year, obtained through steam from coals, may be about ten times the rental of forty acres at £2 or £3 per acre. But the value of land is essentially much more than its rental, and the rental of land is apt to be much more than £2 or £3 per acre in places where 100 horse-power could be taken with advantage from coal through steam. Thus the question remains unsolved, with the possibility that in one place the answer may be *one hundred horse-power*, and in another *forty acres*. But, indeed, the question is hardly worth answering, considering

* Read at the Royal Society of Edinburgh on February 2, 1852 (*Proceedings* of that date).

† A general conclusion equivalent to this was published by Sir John Herschel in 1833. See his "Astronomy," edit. 1849, § (399).

the rarity of the cases, if they exist at all, where embankments for the utilisation of tidal energy are practicable.

Turning now to sources of energy derived from sun-heat, let us take the wind first. When we look at the register of British shipping and see 40,000 vessels, of which about 10,000 are steamers and 30,000 sailing ships, and when we think how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world at the present time, and when we consider the sailing ships of other nations, which must be reckoned in the account, and throw in the little item of windmills, we find that, even in the present days of steam ascendency, old-fashioned Wind still supplies a large part of all the energy used by man. But however much we may regret the time when Hood's young lady, visiting the fens of Lincolnshire at Christmas, and writing to her dearest friend in London (both sixty years old now if they are alive), describes the delight of sitting in a bower and looking over the wintry plain, not desolate, because "windmills lend revolving animation to the scene," we cannot shut our eyes to the fact of a lamentable decadence of wind-power. Is this decadence permanent, or may we hope that it is only temporary? The subterranean coal-stores of the world are becoming exhausted surely, and not slowly, and the price of coal is upward bound—upward bound on the whole, though no doubt it will have its ups and downs in the future as it has had in the past, and as must be the case in respect to every marketable commodity. When the coal is all burned; or, long before it is all burned, when there is so little of it left and the coal-mines from which that little is to be excavated are so distant and deep and hot that its price to the consumer is greatly higher than at present, it is most probable that windmills or wind-motors in some form will again be in the ascendant, and that wind will do man's mechanical work on land at least in proportion comparable to its present doing of work at sea.

Even now it is not utterly chimerical to think of wind superseding coal in some places for a very important part of its present duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want to let the thing be done is cheap windmills. A Faure cell containing 20 kilos. of lead and minium charged and employed to excite incandescent vacuum-lamps has a light-giving capacity of 60-candle hours (I have found considerably more in experiments made by myself; but I take 60 as a safe estimate). The charging may be done uninjuriously, and with good dynamical economy, in any time from six hours to twelve or more. The drawing-off of the charge for use may be done safely, but somewhat wastefully, in two hours, and very economically in any time of from five hours to a week or more. Calms do not last often longer than three or four days at a time. Suppose, then, that a five-days' storage-capacity suffices (there may be a little steam-engine ready to set to work at any time after a four-days' calm, or the user of the light may have a few candles or oil-lamps in reserve, and be satisfied with them when the wind fails for more than five days). One of the 20-kilo. cells charged when the windmill works for five or six hours at any time, and left with its 60-candle hours' capacity to be used six hours a day for five days, gives a 2-candle light. Thus thirty-two such accumulator cells soused would give as much light as four burners of London 16-candle gas. The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam-engine capable of working at the same horse-power as the windmill when in good action. But windmills as hitherto made are very costly machines; and it does not seem probable that, without inventions not yet made, wind can be economically used to give light in any considerable class of cases, or to put energy into store for work of other kinds.

Consider, lastly, rain-power. When it is to be had in places where power is wanted for mills and factories of any kind, water-power is thoroughly appreciated. From time immemorial, water-motors have been made in large variety for utilising rain-power in the various conditions in which it is presented, whether in rapidly-flowing rivers, in natural waterfalls, or stored at heights in natural lakes or artificial reservoirs. Improvements and fresh inventions of machines of this class still go on; and some of the finest principles of mathematical hydrodynamics have, in the lifetime of the British Association, and, to a considerable degree, with its assistance, been put in requisition for perfecting the theory of hydraulic mechanism and extending its practical applications.

A first question occurs: Are we necessarily limited to such natural sources of water-power as are supplied by rain falling on hill-country, or may we look to the collection of rain-water in tanks placed artificially at sufficient heights over flat country to supply motive power economically by driving water-wheels? To answer it: Suppose a height of 100 metres, which is very large for any practicable building, or for columns erected to support tanks; and suppose the annual rainfall to be three-quarters of a metre (30 inches). The annual yield of energy would be 75 metre-tons per square metre of the tank. Now one horse-power for 365 times 24 hours is 236,500 foot-tons; and therefore, dividing this by 75, we find 3153 sq. metres as the area of our supposed tank required for a continuous supply of one horse-power. The prime cost of any such structure, not to speak of the value of the land which it would cover, is utterly prohibitory of any such plan for utilising the motive power of rain. We may or may not look forward hopefully to the time when windmills will again "lend revolving animation" to a dull flat country; but we certainly need not be afraid that the scene will be marred by forests of iron columns taking the place of natural trees, and gigantic tanks overshadowing the fields and blackening the horizon.

To use rain-power economically on any considerable scale we must look to the natural drainage of hill country, and take the water where we find it either actually falling or stored up and ready to fall when a short artificial channel or pipe can be provided for it at moderate cost. The expense of aqueducts, or of underground water-pipes, to carry water to any great distance—any distance of more than a few miles or a few hundred yards—is much too great for economy when the yield to be provided for is *power*; and such works can only be undertaken when the *water itself* is what is wanted. Incidentally, in connection with the water supply of towns, some part of the energy due to the head at which it is supplied may be used for power. There are, however, but few cases (I know of none except Greenock) in which the energy to spare over and above that devoted to bringing the water to where it is wanted, and causing it to flow fast enough for convenience at every opened tap in every house or factory, is enough to make it worth while to make arrangements for letting the water-power be used without wasting the water-substance. The cases in which water-power is taken from a town supply are generally very small, such as working the bellows of an organ, or "hair-brushing by machinery," and involve simply throwing away the used water. The cost of energy thus obtained must be something enormous in proportion to the actual quantity of the energy, and it is only the smallness of the quantity that allows the convenience of having it when wanted at any moment, to be so dearly bought.

For anything of great work by rain-power, the water-wheels must be in the place where the water supply with natural fall is found. Such places are generally far from great towns, and the time is not yet come when great towns grow by natural selection beside waterfalls, for power; as they grow beside navigable rivers, for shipping. Thus hitherto the use of water-power has been confined chiefly to isolated factories which can be conveniently placed and economically worked in the neighbourhood of natural waterfalls. But the splendid suggestion made

about three years ago by Mr. Siemens in his presidential address to the Institution of Mechanical Engineers, that the power of Niagara might be utilised, by transmitting it electrically to great distances, has given quite a fresh departure for design in respect to economy of rain-power. From the time of Joule's experimental electro-magnetic engines developing 90 per cent of the energy of a Voltaic battery in the form of weights raised, and the theory of the electro-magnetic transmission of energy completed thirty years ago on the foundation afforded by the train of experimental and theoretical investigations by which he established his dynamical equivalent of heat in mechanical, electric, electro-chemical, chemical, electro-magnetic, and thermoclastic phenomena, it had been known that potential energy from any available source can be transmitted electro-magnetically by means of an electric current through a wire, and directed to raise weights at a distance, with unlimitedly perfect economy. The first large-scale practical application of electro-magnetic machines was proposed by Holmes in 1854, to produce the electric light for light-houses, and persevered in by him till he proved the availability of his machine to the satisfaction of the Trinity House and the delight of Faraday in trials at Blackwall in April, 1857, and it was applied to light the South Foreland lighthouse on December 8, 1858. This gave the impulse to invention; by which the electro-magnetic machine has been brought from the physical laboratory into the province of engineering, and has sent back to the realm of pure science a beautiful discovery—that of the fundamental principle of the dynamo, made triply and independently, and as nearly as may be simultaneously, in 1867 by Dr. Werner Siemens, Mr. S. A. Varley, and Sir Charles Wheatstone; a discovery which constitutes an electro-magnetic analogue to the fundamental electrostatic principle of Nicholson's revolving doubler, resuscitated by Mr. C. F. Varley in his instrument "for generating electricity"; patented in 1860; and by Holtz in his celebrated electric machine; and by myself in my "replenisher" for multiplying and maintaining charges in Leyden jars for heterostatic electrometers, and in the electrifier for the siphon of my recorder for submarine cables.

The dynamos of Gramme and Siemens, invented and made in the course of these fourteen years since the discovery of the fundamental principle, give now a ready means of realising economically on a large scale, for many important practical applications, the old thermo-dynamics of Joule in electro-magnetism; and, what particularly concerns us now in connection with my present subject, they make it possible to transmit electro-magnetically the work of waterfalls through long insulated conducting wires, and use it at distances of fifties or hundreds of miles from the source, with excellent economy—better economy, indeed, in respect to proportion of energy used to energy dissipated than almost anything known in ordinary mechanics and hydraulics for distances of hundreds of yards instead of hundred of miles.

In answer to questions put to me in May, 1879,* by the Parliamentary Committee on Electric Lighting, I gave a formula for calculating the amount of energy transmitted, and the amount dissipated by being converted into heat on the way, through an insulated copper conductor of any length, with any given electro-motive force applied to produce the current. Taking Niagara as example, and with the idea of bringing its energy usefully to Montreal, Boston, New York, and Philadelphia, I calculated the formula for a distance of 300 British statute miles (which is greater than the distance of any of those four cities from Niagara, and is the radius of a circle covering a large and very important part of the United States and British North America), I found almost to my surprise that, even with so great a distance to be provided for, the conditions are thoroughly practicable with good economy, all aspects of the case carefully considered. The formula itself will be the subject of a technical communication to Section A in the course of the Meeting on which we are now entering. I therefore at present restrict myself to a slight statement of results.

1. Apply dynamos driven by Niagara to produce a difference of potential of 80,000 volts between a good earth-connection and the near end of a solid copper wire of half an inch (1·27 centimetre) diameter, and 300 statute miles (483 kilometres) length.

2. Let resistance by driven dynamos doing work, or by electric lights, or, as I can now say, by a Faure battery taking in a charge, be applied to keep the remote end at a potential differing by 64,000 volts from a good earth-plate there.

3. The result will be a current of 240 webers through the wire taking energy from the Niagara end at the rate of 26,250 horse-power, losing 5250 (or 20 per cent) of this by the generation and dissipation of heat through the conductor and 21,000 horse-power (or 80 per cent of the whole) on the recipients at the far end.

4. The elevation of temperature above the surrounding atmosphere, to allow the heat generated in it to escape by radiation and be carried away by convection is only about 20° Centigrade; the wire being hung freely exposed to air like an ordinary telegraph wire supported on posts.

5. The striking distance between flat metallic surfaces with difference of potentials of 80,000 volts (or 75,000 Daniell's) is (Thomson's "Electrostatics and Magnetism," § 340) only 18 millimetres, and therefore there is no difficulty about the insulation.

6. The cost of the copper wire, reckoned at 8d. per lb., is £37,000, the interest on which at 5 per cent is £1900 a year. If 5250 horse-power at the Niagara end costs more than £1900 a year, it would be better economy to put more copper into the conductor; if less, less. I say no more on this point at present, as the economy of copper for electric conduction will be the subject of a special communication to the Section.

I shall only say, in conclusion, that one great difficulty in the way of economising the electrical transmitting power to great distances, or even to moderate distances of a few kiloms., is now overcome by Faure's splendid invention. High potential—as Siemens, I believe, first pointed out—is the essential for good dynamical economy in the electric transmission of power. But what are we to do with 80,000 volts when we have them at the civilised end of the wire? Imagine a domestic servant going to dust an electric lamp with 80,000 volts on one of its metals? Nothing above 200 volts ought on any account ever to be admitted into a house or ship or other place where safeguards against accident cannot be made absolutely and for ever trustworthy against all possibility of accident. In an electric workshop 80,000 volts is no more dangerous than a circular saw. Till I learned Faure's invention I could but think of step-down dynamos, at a main receiving station, to take energy direct from the electric main with its 80,000 volts, and supply it by secondary 200-volt dynamos or 100-volt dynamos, through proper distributing wires, to the houses and factories and shops where it is to be used for electric lighting, and sewing-machines, and lathes, and lifts, or whatever other mechanism wants driving power. Now the thing is to be done much more economically, I hope, and certainly with much greater simplicity and regularity, by keeping a Faure battery of 40,000 cells always being charged direct from the electric main, and applying a methodical system of removing sets of 50, and placing them on the town-supply circuits, while other sets of 50 are being regularly introduced into the great battery that is being charged, so as to keep its number always within 50 of the proper number, which would be about 40,000 if the potential at the emitting end of the main is 80,000 volts.

* Printed in the Parliamentary Blue-book Report of the Committee on Electric Lighting, 1879.

Tin Mining at Billiton.—M. Ferrier.—The yield of tin at Billiton is now decidedly greater than in the neighbouring Island of Banca.—*Revue Universelle des Mines.*

ON THE NEW METAL ACTINIUM.

By Dr. T. L. PHIPSON, F.C.S., &c.

SINCE the publication of my two notes in the CHEMICAL NEWS, vol. xliii., p. 283, and vol. xliv., p. 73, I have made a great number of experiments with the view of isolating the new substance to which the white zinc pigment owes its remarkable property of darkening in the sunlight, returning to its white state in the dark, and not being affected in this manner under a sheet of glass.

These experiments have at last proved successful, and a very short note to that effect was communicated, about a fortnight ago, to the Académie des Sciences, and another to the British Association on Monday, September 5. I will now describe the process by which I have isolated the oxide and the sulphide of the new metal in a state of tolerable purity. Perhaps this process may be improved hereafter, but it is not very complicated, though it has required an enormous number of experiments to arrive at it. First, one word as to the manner in which the pigment found in commerce is prepared. Ordinary zinc scrap is dissolved in sulphuric acid and a considerable excess of zinc is left in the solution in order to keep out iron, lead, arsenic, and other metals. The liquid is drawn off and then precipitated by a solution of sulphide of barium; the precipitate is dried, calcined, raked whilst hot into cold water, dried again, ground, &c. It then consists of sulphide of zinc, oxide of zinc, and sulphate of baryta, with *minute* quantities of iron, lead, arsenic, manganese, &c.

The manner in which I have obtained the oxide and sulphide of actinium from this pigment is as follows, and the process will doubtless serve for the treatment of other substances in which the presence of the new metal may be detected :—

About 15 grms. of the finely pulverised pigment are left for 24 hours in dilute acetic acid (strongest acetic acid and water equal parts) and the mixture well stirred or shaken occasionally. This takes out most of the iron, manganese, magnesia, lime, and *oxide* of zinc. The residue, after being washed, is treated exactly in the same manner with dilute hydrochloric acid (acid 8 parts, water 92 parts); with the object of completing the action of the acetic acid. The residue, well washed, is then heated with strong hydrochloric acid, to which a little nitric acid is added from time to time. The solution of the chlorides thus obtained is filtered to separate free sulphur and the insoluble sulphate of baryta, any remaining sulphur in suspension after filtration being oxidised by a few crystals of chlorate of potash. To this solution of chlorides, somewhat diluted, a considerable excess of caustic soda is added and the solution heated. The zinc oxide goes into solution and the white oxide of actinium remains; the latter is received upon a filter, washed, dissolved in hydrochloric acid, and the solution again treated with excess of caustic soda (these operations may be repeated two or three times, in order to eliminate the zinc oxide as completely as possible). Finally, the oxide of actinium, still impure, is washed on a filter and dissolved in a considerable excess of hydrochloric acid. The solution is neutralised by ammonia, and then the latter is added in excess. All but a little iron oxide remains dissolved (if not, dissolve again in HCl and add ammonia in excess, which, this time, will only precipitate the iron). The iron oxide is separated by the filter, and to the filtrate sulphide of ammonium is added, which throws down the sulphide of actinium as a bulky pale canary-yellow precipitate, the colour of which is best seen when it is received on a filter.

Oxide of Actinium.—The hydrate as precipitated by soda or ammonia forms a bulky white precipitate more gelatinous than oxide of zinc; unlike the latter it is only very slightly soluble in caustic soda, even when the liquid is heated; it is not precipitated by ammonia from solutions containing ammoniacal salts. It is a permanent white, with a slight tinge of salmon colour when seen in bulk, and it does not change colour when exposed to the air, as oxide of manganese does, neither does it appear to be affected by the direct rays of the sun. It is readily soluble in acids. The anhydrous oxide is not volatile nor decomposed by heat. It has a pale fawn-coloured tint.

Sulphide of Actinium.—The hydrate as precipitated from its neutral or alkaline solutions by sulphide of ammonium is a bulky pale canary-yellow precipitate, insoluble in excess of sulphide of ammonium, scarcely at all soluble in acetic acid, readily soluble in mineral acids even when they are diluted. When exposed to the direct rays of the sun it darkens and becomes quite black in about twenty minutes, except in those places where it is protected by a piece of ordinary window glass.

The quantity of actinium sulphide obtained from the white pigment amounts to no less than about 4 per cent. This yield is enormous. The presence of this new element in zinc will account, probably, for the discrepancies noticed in the *equivalent* of this metal as determined by various observers. The new element differs very essentially from manganese, zinc, and cadmium, but has, perhaps, some points of similarity with lanthanum. It exists, evidently, in considerable quantities in, at least, some kinds of commercial zinc. As soon as I shall have written the next number of my "Journal of Medicine," I intend to pursue these investigations.

ON THE NATURE OF CERTAIN VOLATILE PRODUCTS CONTAINED IN CRUDE COAL-TAR BENZENES.

By WATSON SMITH, F.C.S., F.I.C.,
Demonstrator and Assistant Lecturer on Chemistry in the Owens College.

VINCENT and DELACHANAL (*Comptes Rendus*, lxxxvi., 340), on rectifying crude benzene, obtained in the usual way, from the "light oils" of certain Paris coal-tars, received over a certain quantity of products boiling below 80° C. On standing, a separation of the portion boiling below 80°, into two layers, took place, a lower one much heavier than water, composed chiefly of carbon bisulphide, and an upper layer lighter than water. Submitting the upper layer to distillation, carbon bisulphide was received over below 75°; the portion distilling between 75° and 83°, on treatment with a lye of potash, or soda, or with lime, and distilling in a retort with inverted condenser, disengaged torrents of ammonia, and an acetate was formed and remained in the alkaline liquid. When the disengagement of ammonia had ceased, there remained in the apparatus with the excess of alkaline lye and the acetate, a liquid product, which, when distilled and dried over quicklime, presented all the properties of anhydrous ethyl-alcohol. The decomposition with alkalies yielding ammonia and an acetate indicated the presence of aceto-nitrile, and this was separated from the alcohol as follows :—By fractional distillation the products were classified as much as possible, and afterwards the largest possible quantity of previously fused and powdered calcium chloride was dissolved in the boiling mixture in order to absorb the alcohol, which it does on cooling, forming a kind of unstable compound. Repeated distillations and treatments with calcium chloride at length gave an aceto-nitrile, containing but traces of alcohol, which were finally eliminated by a distillation from a small quantity of phosphorus pentoxide, followed by a rectification. It may be mentioned that though alcohol boils at 78·4° and aceto-nitrile at 81·6°, yet mixtures of equal parts of these two bodies boil at a much lower temperature, viz., 72·7°. The lower layer of liquid of the crude products consisted of carbon bisulphide mixed with very small quantities of hydrocarbons, apparently containing amylen.

Otto Witt (*Berichte der Deutschen Chemischen Gesellschaft*, 1877, page 2227) likewise found ethyl-alcohol

in the benzenes from certain Paris coal-tars. The quality tested was the so-called 90 per cent aniline-benzene. Witt obtained by a fractional distillation 5 to 6 per cent of a product distilling over between 60° and 70°. On renewed fractionation a turbid product was obtained, gradually separating into two layers, the lower one consisting of carbon bisulphide and the upper one of ethyl-alcohol. The amount of alcohol according to Witt was about 0·2 per cent on the benzene operated on. Witt, moreover, asserts that ethyl-alcohol continually accompanies benzene obtained from coal-tar.

My own experiments were made with a sample of benzene from a London tar kindly furnished me by my friend Mr. Chas. Lowe, of Reddish and Manchester. The benzene received was from the so-called "first runnings" of the still. Mr. Lowe informed me that several London tar distillers had been much troubled by complaints from their customers that the "aniline-benzenes" sold to them contained certain low-boiling substances, whose presence had the effect of reducing the boiling-point of the mixture, and of course also themselves contributing to make up the bulk of the benzenes, appeared to confer a fictitious value upon the article. In some cases it was even insinuated that petroleum spirit had been purposely introduced. The distillers appeared quite unable to account for the anomaly.

The specific gravity of the benzene was first determined, and found to be 0·911 at 15°. This being considerably above the correct specific gravity of benzene, viz., 0·880 at 15°, a portion was now distilled, and the specific gravity of all coming over below 80° was determined, and also that of all boiling between 80° and 90°. The numbers obtained were, respectively, 0·954 and 0·887 at 15°. The portion boiling below 80° was again distilled, and all coming over below 74° taken apart. This was found to smell disagreeably, and to sink in water, forming transparent, strongly refractive, oily drops. The portion sinking in water began to distil at 45°. I never observed the least tendency of any of the products I obtained to separate into two layers, as in the case of the benzenes operated upon by Vincent and Delachanal and by Otto Witt; also, all fractions obtained between 50° and 80°, on further fractionation, always split up into portions boiling at or below 50°, or at and above 80°. After some seven weeks of continual fractional distillation I succeeded in splitting up all my products into three main portions—

1. Boiling from 40° to 53°
2. ,, ,, 81° to 82°
3. ,, above 82°

It did not now seem probable that either alcohol or aceto-nitrile were present appreciably. In course of the fractionating, a fraction boiling from 65° to 80° was obtained. This was sealed up in a glass tube with a lye of caustic soda. A portion of that placed above as No. 2, and boiling from 81° to 82° was similarly treated. The two tubes were heated to 100° for two days, but on opening not the least odour of ammonia was perceptible.

All efforts to detect alcohol in this benzene resulted only in evidence of minute traces. Vincent and Delachanal's method of treatment with powdered calcium chloride entirely failed to abstract any, and distillation of the No. 2 portion with very small fragments of sodium was then resorted to, with the object of fixing traces of alcohol. The residue obtained was carefully dried, but by the action of water and final testing, only traces of alcohol could be found.

The portion No. 1, boiling at from 40° to 53° and sinking in water, having also the odour of ordinary carbon bisulphide was now treated gradually with bromine. The first additions were at once decolourised. So much bromine was now added that a permanent brown colour remained in the solution. At first the action was totally unaccompanied by liberation of HBr; when a slight excess of bromine was, however, added, some fumes of HBr appeared, indicating that also a small quantity of substitution-compounds is formed. On leaving the brominated mixture in a flask loosely corked, the neck was after twenty-four hours found covered with fine acicular crystals, and a few drops of a heavy oily bromine compound had settled down to the bottom of the vessel. The mixture was now distilled, when the carbon bisulphide first came over, together with the heavy brown oily body, which had a most disagreeable and persistent odour, and on separating from the carbon bisulphide it soon solidified to a crystalline mass. Its quantity was very small. It was possibly the bromine compound of a polymeric amylen. Small quantities of products now distilled over from 80° to 140°, but the most considerable fraction was that passing over between 160° and 180°, and on further fractionation yielding a product boiling constantly from 175° to 178°, and possessing the odour of bibrom-amylen. Odour and boiling-point agreeing with those of α- and β-bibrom-amylens, a vapour-density determination by Victor Meyer's method was now made by Mr. Wilhelm Bott, with the following results (a naphthalen bath was used):—

S = 0·12 grm.; t = 17°; w = 14·42 c.c.; B = 758·5 m.m.; V = 13·1 c.c.

Substituting the numbers given in Meyer's formula—

$$d = \frac{S(1+0{\cdot}003665\,t)\,587780}{(B-w)V} = \frac{0{\cdot}12\,(1+0{\cdot}003665\times 17)\,587780}{(758{\cdot}5-14{\cdot}42)\,13{\cdot}1} = 7{\cdot}68$$

V.-d. Found.

V.-d. calc. for $C_5H_{10}Br_2$ = 7·86

The portion which boiled constantly at 81° to 82° is pure benzene. It solidified easily and completely on cooling to 0° C., and was proved to be free from alcohol and aceto-nitrile. The proportion of the carbon bisulphide I found to be present in the crude benzene operated on is 5·92 *per cent by volume*, *i.e.*, from 4220 c.c. of the benzene I obtained 250 c.c. of pure carbon bisulphide. It would seem most probable that the carbon bisulphide is to be traced to the action of a very high temperature in the gas retorts upon coals containing a considerable amount of sulphur. It would appear very possible that at an extremely high temperaturature the tendency of sulphur to form carbon bisulphide in contact with intensely red-hot carbon (coke) would be greater than to form the ordinary sulphur compounds met with in gas-lye products, many of which are probably less stable at extremely elevated temperatures.

With regard to the origin of ethyl-alcohol in coal-tar benzenes, I do not feel able to accept the work of Vincent and Delachanal or of Otto Witt as any proof that the ethyl-alcohol they extracted was actually present in the coal-tars from which the benzene was distilled, until their experiments are repeated with like results, on the crude first portions of the light oils coming direct from the tar-stills. My reason is this. The benzenes they operated upon, as I understand, were rectified products, *i.e.*, the products obtained by treatment of the first light oils with about 3 per cent of concentrated sulphuric acid (volume), followed by agitation with alkaline lyes, and subsequent distillation. Now, with the olefines shown to be present it is almost certain that olefiant gas would also exist in the coal-tar, dissolved in the oils composing the fluid portion thereof. On distilling the tar the olefiant gas would pass over with the first portions of the light oils, and on the condensation of the latter doubtless re-dissolve to a certain extent in these lighter oils. On subsequent treatment with sulphuric acid, ethyl-sulphuric acid would be formed, and the after-treatment with alkali, followed by distillation, would yield a small quantity of ethyl alcohol passing over thus with the rectified benzene. The fact that notwithstanding this treatment with sulphuric acid and alkali, amylene should be found in the rectified benzene is easily explained. The α- and β-amylenes, $CH_3-CH_2-CH_2-CH=CH_2$ and $CH_3-CH_2-CH=CH-CH_3$, which (judging from the boiling-point of the possible mixure of the bibromo-compounds obtained) are probably the

ones contained in the benzene I examined, are neither of them attacked by sulphuric acid in the cold. *a*-iso-amylene—

$$\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!CH-CH=CH_2,$$

is truly not affected by cold sulphuric acid, but its boiling-point is 21°, and from this fact, and remembering that the bisulphide of carbon mixture did not begin to boil till 40°, it is not likely to be present.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING AUGUST 31ST, 1881.

By WILLIAM CROOKES, F.R.S.,
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

September 2nd, 1881.

SIR,—We beg to lay before you the results of our daily examinations of the water delivered, for the month ending the 31st of August, by the seven London water companies taking their supply from the Thames and the Lea. The samples are taken by a man in our service at places and times which we ourselves appoint.

In 6 only of the 182 samples taken during the month were we able to detect by examining the water in large bulk with the naked eye the minutest trace of matter in suspension.

In Table I. we have recorded the analyses in detail of samples, one taken daily from August 2nd to August 31st, inclusive.

The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the 182 samples of water as determined by the colour-meter we have described in a previous report. Practically the waters differ very little in their appearance (even when examined in large bulk) from distilled water. Despite the heavy rain-fall of the month, on four or five days only was the pure blue colour of the water in any degree interfered with.

Of the 26 samples supplied by the New River Company, the whole, excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, all were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole, excepting one sample which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole excepting two which were "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was noted as "very slightly turbid." The rest were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

Our daily examinations of the water delivered to London during the past month satisfy us of its excellent quality, and of its suitability in every way for the supply of the Metropolis.

Further, our results, which are in accordance with those of all chemists who have examined and reported on the subject, show that the water of the Thames in its flow of some hundred and thirty miles as a definite stream, does not acquire any increased proportion of organic matter,—the amounts of organic carbon and of organic nitrogen existing in the water supplied by the companies not exceeding the amounts existing in the river water at Lechlade, where the main stream of the Thames is formed.

We remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ANALYSIS OF KINGSTEAD CHALYBEATE SPRING.

By WILLIAM JOHNSTONE, F.I.C., &c.,
Public Analyst for the Borough of King's Lynn.

THE village of Kingstead is situated about one mile and a half S.E. of Hunstanton, St. Edmunds, a rising and fashionable seaside resort. The most valuable feature of Kingstead, however, is the Chalybeate Spring, which is now being so extensively recommended by the medical faculty. It is situated in Mr. Dodman's farm-yard at the Kingstead Downs, within a delightful walk a short drive from Hunstanton. The following are the direct results obtained from an analysis of the water collected on October 14, 1880, in 1000 parts:—

Ferrous oxide	0·00739
Silica	0·01492
Calcium oxide	0·10007
Magnesium oxide	0·00980
Sulphuric anhydride	0·00912
Chlorine	0·01978
Bromine	0·00043
Phosphoric anhydride	0·00192
Potassium	0·00053
Sodium	0·01241
Carbonic dioxide (combined)	0·14146

Besides the above, it contained traces of free and albumenoid ammonia, crenic and apocrenic acids, with spectroscopic traces of lithium and strontium. The following table shows the name and quantity of the various elements in combination in 1000 parts:—

Specific gravity	1·1465
Temperature of air	52° F.
„ „ water	53° F.
Calcium sulphate	0·01550
„ phosphate	0·00419
„ carbonate	0·22882
Magnesium bromide	0·00144
„ chloride	0·00053
„ carbonate	0·02719
Potassium chloride	0·00056
Sodium chloride	0·03157
Ferrous carbonate	0·01190
Silica	0·01942
	0·34113

Natural gases dissolved in the water:—

Carbonic acid	24·422 c.c.
Nitrogen	32·806 ,,
Oxygen..	5·236 ,,
Total.. ..	62·464 ,,

The following table gives the several constituents expressed in grains per imperial gallon, so as to meet the requirements of the medical adviser:—

Calcium sulphate	1·0850
,, phosphate	0·2933
,, carbonate	16·0174
Magnesium bromide	0·1008
,, chloride	0·0371
,, carbonate	1·9033
Potassium chloride..	0·0392
Sodium chloride	2·2099
Ferrous carbonate	0·8330
Silica	1·3594
	23·8784
Total by direct estimation	23·5200

Natural gases dissolved in the water:—

Carbonic acid	6·507 cub. ins.
Nitrogen	8·776 ,, ,,
Oxygen..	1·400 ,, ,,
Total	16·613 ,, ,,

A NEW DEMONSTRATION OF THE CARBONIC ACID OF THE BREATH.

By C. F. CROSS.

SOME time since I made the observation that the carbonic acid of the breath determines the liberation of iodine from a mixture of potassium iodide and iodate, and that the presence of starch renders the decomposition a very effective lecture-experiment, in demonstration of the presence of an active acid body in respired air. A friend to whom I lately communicated this result, threw doubt upon my interpretation, and while admitting the occurrence of the decomposition under the condition of respiring vigorously into the solution, preferred to attribute it to the action of the air or of acid vapours accidentally present. I therefore repeated the experiment with special precautions, viz., washing the respired gases, and performing parallel experiments, in which, for the breath I substituted a rapid current of air, and lastly raising the latter to a temperature of 40° C. The result was to prove conclusively my original statement that the decomposition is brought about by a constituent of the respired air, and therefore by its carbonic acid. In performing this experiment it is only necessary to secure the neutrality of the solution; this being done the development of a full purple colour occupies from two to three minutes.

It is evident that this demonstration of the presence of *some* acid body precedes the lime-water test in the logical development of the complete proof of the presence of *carbonic* acid.

COPYING INK FOR READILY TRANSCRIBING LETTERS WITHOUT A PRESS.

A PAPER on this subject by Professor Attfield, F.R.S., &c., was read at the annual Pharmaceutical Conference at York, on Tuesday last. The author stated that for the past thirteen years all letters, reports, &c., that he had written had been transcribed into an ordinary thin-paper copying-book with no more effort than was employed in using a piece of blotting-paper. It had only been necessary to place the page of writing, note size, letter size, or even foolscap, in the letter-book, and use a leaf of the letter-book just as one would use a leaf of blotting-paper. The superfluous ink that would go into blotting-paper went on to the leaf of the letter-book, and, showing through the thin paper as usual, gave, on the other side of the leaf, a perfect transcript of the letter. Any excess of ink on the page either of the letter or of the copying paper was removed by placing a sheet of blotting-paper between them and running one's hand firmly over the whole in the ordinary manner.

This ready transcription was accomplished, as would be anticipated, by using ink which dried slowly. Indeed, obviously, the ink must dry sufficiently slowly for the characters at the top of a page of writing to remain wet when the last line was written, while it must dry sufficiently fast to preclude any chance of the copied page being smeared while subsequent pages were being covered. The drying must also be sufficiently rapid to prevent the characters "setting off," as printers term it, from one page on to another after folding.

The author then alluded to some difficulties attending the employment of the ink which had prevented its becoming an article of wholesale trade, but, he said, any chemist and druggist could make it and sell it, giving directions for use to customers. He himself had used it from year's end to year's end without any trouble whatever. It would be particularly useful to professional men and private persons.

The principle of the method of preparation consisted in dissolving a moderately powerful hygroscopic substance in any ordinary ink. After experimenting on all such substances known to him, he gave the preference to glycerin. Reduce, by evaporation, ten volumes of ink to six; then add four volumes of glycerin. Or manufacture some ink of nearly double strength and add to any quantity of it nearly an equal volume of glycerin.

NOTICES OF BOOKS.

A Dictionary of Chemistry and the Allied Branches of Other Sciences. By HENRY WATTS, F.R.S., &c. Third Supplement. Part II. London: Longmans, Green, and Co.

ONLY persons who, like ourselves, find it necessary to keep a constant watch on the progress of chemical science, can form any adequate idea of the more than Herculean labour which Mr. Watts has undertaken. The continual stream of discoveries—some of them of a very high order—necessitates not merely additions to, but modifications of, our previous knowledge in almost every department of chemistry. That the author suceeds in giving so full, fair, and accurate a survey of all this wealth of research, redounds highly to his credit, both for industry and discrimination.

Among the most important articles, most of which are, of course, merely supplemental to what has been written on the same subjects in former volumes, we may mention those on meteorites, naphthalen, phenol, phthaleines, nutrition and respiration of plants, resorcinol, &c. The treatise on thermodynamics almost deserves the rank of a monograph, and along with the section on thermochemistry (under heat) will be of signal utility both to chemists and physicists.

The behaviour of lead with water and the saline solution has been made the subject of many recent investigations, which are here carefully summed up.

The article Light is copious and includes many interesting results in circular polarisation. Under "Refraction and Dispersion," we find an anomaly in nomenclature which we should scarcely have expected. The author uses

"fuchsine" as a trivial synonym for the tinctorial salts of rosaniline. We submit that this word is not English at all. It is incapable of being pronounced by any Englishman unless he is acquainted with the German language, and like the now obsolete terms "azaleine," "roseine," &c., it is ambiguous. We find the same word several times repeated in the article on rosaniline, and in that on saffranine.

The enumeration of meteoric stones which have been found and analysed lately, and many of which have been actually observed falling, is very full.

In the valuable notice on isomerism, which is from the pen of Dr. H. E. Armstrong, one of the ablest and most successful of British chemists, the question is raised whether any two compounds, differing in physical characters, are precisely alike in their so-called chemical properties. "The two tartaric acids, which probably resemble each other more closely than any other two compounds with which we are aquainted, undergo fermentation, it is said, with different degrees of readiness, the dextrorotatory acid disappearing first."

Reference is made to the synthetic preparation of glycerin. The process scarcely admits of industrial application, but if capable of sufficient simplification, it might become very important, now the ordinary source of glycerin—the manufacture of stearic acid—is declining in consequence of the growing disuse of candles.

We find some interesting facts on the so-called fish-guanos prepared in Norway and elsewhere from the refuse of the fisheries. Fish-guanos not free from fat are very slow in putrefying, and, consequently, we may presume, in giving up their valuable constituents to the soil. Treatment with sulphuric acid was also not found advantageous, as the acid even when added to the extent of 30 per cent, was chiefly taken up by the organic matter, and only about 3·60 per cent of phophoric acid, out of a total of 13·89 per cent, was rendered soluble. Some authorities consider it most advantageous to feed cattle with the fish-guano and to use their excrements as manure. What might be the effect of such a diet upon the flesh, milk, &c., of the cattle, does not seem to have been examined.

Concerning the value of the volume before us, comment is scarcely requisite. It is an integral part of a work of reference which no chemist can afford to dispense with.

As far as we can learn, a very general wish has sprung up in chemical circles for a new edition of the whole of "Watts's Dictionary," in which the supplements should be incorporated with the original volumes, and all more recent matter should be introduced under a new arrangement. Of the value of such an edition to chemists there can be but one opinion, and we have no doubt that it would be prized accordingly. Considering the number of persons now engaged in chemical studies, the publishers ought to receive ample support in an undertaking which may well be pronounced of national importance.

Journal and Proceedings of the Royal Society of New South Wales, 1880. Vol. XIV. Edited by A. LIVERSIDGE. Sydney: Thomas Richards. London: Trübner and Co.

THE Royal Society of New South Wales has scarcely been as active as might be wished. Of its sections, those for astronomy, meteorology, physics, mathematics, and mechanics; for chemistry and mineralogy; for geology and palæontology; for biology, and for geography and ethnology, did not meet at all during the past year.

The Vice-President, Mr. G. Moore, F.L.S., in his able anniversary address, regrets that so few papers were read at the general meetings.

Several interesting papers on chemical subjects have, however, been communicated to the Society. Mr. E. H. Rennie has read a paper on the acids of the native currant (*Leptomeria acida*), which appear to be the malic, with probably a small quantity of citric, acid.

Prof. Liversidge has made a careful examination of the alkaloid from piturie. The sample operated upon, was the product of a Solanaceous plant, *Duboisia Hopwoodi*, now named *D. pituri*. The author assigns to the alkaloid the formula $C_{12}H_{16}N_2$. It is distinguished from coneine by its aqueous solution not turning turbid on heating nor on the addition of chlorine-water. It differs from aniline by not being coloured by chloride of lime; it differs from picoline in specific gravity, from pyridine by its reaction with copper sulphate, and is distinguished from nicotine by its behaviour with platinic chloride, gold chloride, iodine, and mercuric chloride.

Prof. Liversidge also communicates the analysis of water from a hot spring in New Britain; and of water from a hot spring at Savu Savu, Fiji Islands.

Other papers by the same author are "On Some New South Wales Minerals" and "Notes on Some Minerals from New Caledonia."

Mr. W. A. Dixon, F.C.S., of the Sydney Technical College, communicates a paper on "Salt-bush and Native Fodder Plants of New South Wales." In all of them, except the "old man" and the "cotton-bush," the total digestible matter falls below that of European fodders.

Mr. Dixon also read a paper on the "Inorganic Constituents of the Coals of New South Wales."

From a paper on the "Causation and Prevention of Insanity," read before the Medical Section by F. Norton Manning, M.D., we quote this significant passage:—"I know no stronger evidence as to the evil done by over work at schools and competitive examinations than that of Dr. Andrew Clarke, who states that he has discovered temporary albuminuria in 10 per cent of the candidates sent to him for examination as to physical health after passing the Civil Service examination for India."

From certain passages in this Journal, we fear that the Australians labour under a delusion, from which the mother-country and America are just recovering, *i. e.*, the notion that they have no time for science. National prosperity, in these days, is not to be compassed by rule-of-thumb.

CORRESPONDENCE.

PREPARATION OF PURE NAPHTHALEN.

To the Editor of the Chemical News.

SIR,—Mr. Staveley, in the CHEMICAL NEWS, vol. xliv., p. 85, makes some remarks upon my communication on the above subject, to which I beg to reply briefly.

Divested of its courteous garb, his objection comes to this, that my communication was unnecessary, inasmuch as it is the easiest thing in the world to make perfectly pure naphthalen, and everybody concerned knows all about it. To this I oppose the following *fact*:—Last autumn I made a tour in England, Germany, and France, for the sole purpose of collecting information about the newest plant and processes for tar distilling, in connection with my forthcoming treatise on this subject. I found that several large tar distillers did *not* know how to make permanently white naphthalen, and frankly confessed as much. Others certainly professed to know it, but treated it as a great *secret*. Those who really manufacture naphthalen remaining permanently white in cakes (not merely in flakes!), wrapped themselves up in complete mystery. Hence, when I found I could fill up that gap from my own experiments, I believed that I could render a slight service to technical chemistry by publishing my process, and to that opinion I adhere still, *pace* Mr. Staveley. It is all very well to say now in a general way that the use of MnO_2, and other oxidising agents for the purpose of purifying tar products is known to most tar works chemists, at least in the laboratory; the fact is that before my pub-

lication, MnO_2, &c., was nowhere stated to effect a permanent decolourisation of naphthalen, that I found this out for myself by reasoning and experiment, and that a large tar distiller, to whom I communicated my process, and who found it to answer *on the large scale*, recognised it to be a novelty worthy of remuneration. This also disposes of the objection that it is unfair to compare my samples with those prepared at the works. Neither was it incumbent upon me to say anything about hydraulic pressure in my short note; *that* would have been unnecessary, as everybody knows all about it.

As far as the cause of the pink discolouration is concerned, Mr. Staveley too generously credits me with having originated the supposition that aurin may be formed by the oxidation of a mixture of phenol and cresol. This reaction is known to everybody who has studied the chemistry of the coal-tar colours; it is precisely analogous to the formation of rosaniline from aniline and toluidine. Zulkowsky has actually prepared aurin by that very reaction (*Berlin Berichte*, x., 1201; abstracted *Journ. Chem. Soc.*, 1877, ii., 888), and it has been carried out at Cologne on a manufacturing scale (*Wagner's Jahresberichte*, 1878, p. 1066). I hope Mr. Staveley is satisfied on this point now.

Unfortunately the "interesting observation" made by Mr. Staveley, that lime hastens the development of a pink colour in the presence of air, is not quite new. Runge made it half a century ago, and was thereby led to the discovery of rosolic acid, and every other chemist who has worked on this subject has noticed it likewise. Only the explanation given by Mr. Staveley is novel, but not equally convincing to my mind; for, if not the O but the CO_2 of the air causes the formation of the colouring-matters, the presence of lime, which absorbs the CO_2, ought to prevent, instead of assisting, that reaction.

It is not very encouraging to those who are desirous of spreading a knowledge of technical chemistry, if they have to waste their time and the space of scientific periodicals in defending themselves for taking that liberty.—I am, &c.,

G. Lunge.

Zürich, August 22, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 3, July 18, 1881.

Researches on Glycolic Ether and the Oxides of Ethylen.—M. Berthelot.—A thermo-chemical paper; the author has determined the evaporation-heat of glycolic ether as +6·1 cals.; its solution-heat at 13° in 160 parts of water at +1·5 cals.; its formation-heat from its elements (C_4, diamond, $+H_4+O_2$) +17·7 cals. The heat developed by the transformation of ethylen into glycolic ether is +33 cals.

Distribution of Energy in the Normal Spectrum.—M. Lengley.—According to the author's investigations made with a novel instrument the energy is feeble in the ultra-violet, whilst the rapid increase towards the blue contrasts with the slow decrease towards the red. At the very place of the maximum ordinarily placed in this region there is in reality merely a point of inflection. The so-called curve of light coincides almost exactly with that of heat, instead of being totally distinct as hitherto believed. Hence the luminous effects of solar energy upon the retina are approximately proportional to those of heat upon the thermometer.

Hydrosulphurous Acid.—M. Schützenberger.—A reply to the communication of M. Bernthsen (*Comptes Rendus*, July 11, 1881). The author contends that the results of M. Bernthsen prove nothing against his formula.

A Method of Amplifying the Displacements of the Plane of Polarisation of Light.—H. Becquerel.—Not suitable for abstraction.

Speed of the Propagation of Ignition in Explosive Gaseous Mixtures.—MM. Mallard and Le Chatellier.—With mixtures of hydrogen and air the maximum speed is produced with a mixture containing about 10 per cent more hydrogen than the theoretical detonating mixture. When gases are heated their speed of propagation increases. The diameter of the tube has no notable influence upon the speed, except it is very small.

Splitting up and Enlargement of the Bands of the Rainbow.—C. Ritter.—If the drops of water are at a less distance than 1·50 metres, we ought, when looking at them with both eyes, to perceive two distinct bows or rings; these bows will have their maximum interval on their horizontal diameter, and the interval, in the form of a crescent which separates the inner violet of the one from the outer red of the other, will decrease progressively to the upper and lower points of intersection of the two rings. At the distance of 1·50 metres the two bows are in contact, violet against red, on the horizontal line. Beyond 1·50 metres the bows cross each other on their whole circumference, but without ever producing complete superposition.

Action of Sulphur upon Certain Metallic Solutions.—MM. E. Filhol and Senderens.—If finely divided sulphur is mixed with a solution of lead sulphate and the mixture boiled, lead sulphide is deposited, and the sulphuric acid is set at liberty. The authors show that this result is to be foreseen according to the principles laid down in the *Traité de Mécanique Chimique* of M. Berthelot. Silver carbonate, oxalate, nitrate, and acetate are also decomposed in the same manner. Silver chloride has not been decomposed. Lead sulphate is decomposed very slowly, and the supernatant liquid is not acid. Copper sulphate, nitrate, and chloride have not been appreciably decomposed.

Separation and Determination of Alumina and the Ferric and Chromic Oxides.—A. Carnot.—Inserted in full.

The Magnesia Industry.—T. Schlœsing.—The author speaks in the first place of two distinct systems of dealing with fœcal matter: water-carriage in sewers and the separate collection of the excrements, and their conversion into portable manures. For this purpose the author recommends an addition of phosphoric acid and magnesia, so as to form in combination with the ammonia of the urine, &c., an ammonium-magnesian phosphate. A plentiful supply of magnesia at a cheap rate is necessary. He shows the impracticability of obtaining magnesia on a commercial scale by precipitating its saline solutions with the milk of lime. He then refers to a process which he will describe on a future occasion.

Experiments with Phenol, Ammonium, Phenate, &c., on Patients Suffering from Yellow Fever.—M. de Lacaille.—The author, a physician practising at Rio de Janeiro, has used phenol successfully in yellow fever. In one of the cases the "black vomit" had already set in.

Revue Universelle des Mines, de la Metallurgie, &c., Tome 9, No. 2, March and April, 1881.

Researches on the Chemical Stability of Explosives.—P. von Hess.—Not adapted for abstraction.

Note on the Beds and the Working of Guano in the South of Peru.—E. G. Detienne.—The author remarks that the meridian circle of elevation passes by the Gallapagos Islands, Huancavelica, Monte Video, Sumatra, Japan, and the Aleutians. On this track mercury is everywhere associated with thermal waters, and sometime

gushes up alone. He considers that the production of guano has ceased long ago. The birds by which it was deposited have ceased to exist, and on this coast only nitrate of soda offers the prospect of prolonged working on a large scale.

The Mineral Wealth of Maxos, Paros, and the Cyclades.—M. Rosseel.—The products of these islands are emery, marble, argentiferous galena, calamine, sulphur, the yearly yield of which is about 1200 tons, mill stones and manganiferous hæmatite.

New Process for the Volumetric Determination of Potassium.—L. L. de Koninck.—The potassium is thrown down, with the ordinary precautions, by platinum chloride; the K_2PtCl_6 is collected on a filter, washed in alcohol, and immediately dissolved in boiling water. The solution is reduced hot by magnesium. All the chlorine of the chloro-platinate is obtained in the form of a soluble chloride, and a black precipitate of reduced platinum. At the same time the magnesium decomposes the water, yielding hydrated magnesia with an escape of hydrogen. When the reduction is complete the mixture is filtered, and in the neutral solution the chlorine is determined in the usual manner with a standard solution of silver nitrate, using potassium chromate as indicator.

Journal für Praktische Chemie.
No. 11, 1881.

The Compounds of the Mono- and Bi-basic Fatty Acids with Phenols (Second and Third Treatises).—M. Nencki and N. Sieber.—The authors describe the preparation and properties of two colouring-matters, acet-fluoresceine and resaceteine, the former of which is characterised by a fine green fluorescence.

Anthology of Modern Chemical Utterances.—H. Kolbe.—Continued from No. 9, and deserving careful attention.

Two Spurious Inaugural Dissertations.—Detected and made known by H. Kolbe and E. von Meyer.—The two dissertations are *verbatim* piracies. The offenders are not known in England, and the publication of their names would therefore be useless.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 1, May 5, 1881.

Action of Ammonia upon Isatin.—Dr. E. von Sommaruga.—Isatin contains at least one hydroxyl group. Diamide, a derivative of isatin, gives rise to ammonia under the action of alkalies, even if dilute, which causes us to suppose the presence of a group of amide in the diamide, and of a hydroxyl group in the isatin.

New Hydrocarbon.—J. Kachler and F. V. Spiher.—This compound is hydrocamphen. It is obtained by the substitution of hydrogen for chlorine in the compounds $C_{10}H_{17}Cl$.

Oxidation of Quinine.—Quinine, in place of cinchonic acid, yields a new nitrogenous compound, quinic acid, of a light yellow colour, slightly soluble in water, even at 100°. Its salts crystallise readily, and are characterised by an odour like that of coumarine, which they give off if heated.

No. 2, May 2, 1881.

This issue contains no chemical matter save what is extracted from other journals.

MISCELLANEOUS.

Hot-air Engines.—At the Royal Manchester and Liverpool Agricultural Society's show, held at Blackburn, September 1, 2, and 3, Messrs. W. H. Bailey and Co., of the Albion Works, Salford, exhibited their slow-combustion hot-air engine, for which they obtained the first class silver medal for its excellence and superiority.

British Association for the Advancement of Science.—The Jubilee Meeting at York, both as regards the number of members and associates attending and the importance of the papers read, has admittedly been a great success. In 1879 at Sheffield the total was 1404, and at Swansea last year 915, but this year the number has risen to 2533, which includes 22 foreign members, 510 ladies, and 1173 associates. The following is the synopsis of grants of money appropriated to scientific purposes by the general committee:—The Council, Exploration of Mountain District of Eastern Equatorial Africa, £100. Mathematics and Physics—Mr. G. H. Darwin, Lunar Disturbance of Gravity, £15; Dr. A. Schuster, Meteoric Dust, £20; Professor Sylvester, Fundamental Invariants (partly renewed), £30; Mr. R. H. Scott, Synoptic Charts of the Indian Ocean, £50; Professor G. C. Foster, Standards for use in Electrical Measurements (partly renewed), £100. Chemistry—Professor Dewar, Present state of Knowledge of Spectrum Analysis, £5; Professor Balfour Stewart, Calibration of Mercurial Thermometers, £20; Professor Roscoe, Wave-lengths Tables of Spectra of Elements, £50; Dr. Hugo Müller, Chemical Nomenclature, £10; Professor Odling, Photographing the Ultra-Violet Spark Spectra, £25. Geology—Dr. J. Evans, Record of the Progress of Geology, £100; Professor Ramsay, Earthquake Phenomena of Japan, £25; Dr. H. C. Sorby, Conditions of Conversion of Sedimentary Materials into Metamorphic Rocks, £10; Professor W. C. Williamson, Fossil Plants of Halifax, £15; Professor A. C. Ramsay, Geological Map of Europe, £25; Professor E. Hull, Circulation of Underground Waters, £15; Professor W. C. Williamson, Tertiary Flora associated with the Basalts of the North of Ireland, £20; Dr. Sorby, British Fossil Polyzoa, £10; Professor Leith-Adams, Carboniferous Limestone Caves in South Ireland, £10; Professor Green, Exploration of Reygill Fissure, £20. Biology—Mr. F. M. Balfour, Table at the Zoological Station at Naples, £80; Dr. Burdon Sanderson, Albumenoid Substances of Serum, £10; Dr. Pye-Smith, Influence of Bodily Exercise on the Elimination of Nitrogen, £50; Dr. M. Foster, Zoological Station in Scotland, £40; Mr. J. Cordeaux, Migration of Birds, £15; Lieut.-Colonel Godwin-Austen, Natural History of Socotra, £100; Mr. Thiselton-Dyer, Natural History of Timor Laut, £100; Mr. Stainton, Record of Zoological Literature, £100; Professor Flowers, Photographs of Typical Races, £10. Statistics—W. F. Galton, Anthropometry, £50—£1280. The meeting in 1882 will be held at Southampton under the presidency of Dr. C. W. Siemens, and Oxford has been selected for the Association's meeting in 1883.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

White Naphthalen.—J. W. T. can procure commercial "white naphthalen," in any quantity, at a price of about £10 per ton, and a sample can be had if he will forward his address.—B.

TO CORRESPONDENTS.

Sutton.—No process is known which will suit your requirements.

NOTICE.

The STUDENTS' NUMBER of the Chemical News, will be published on Friday, September 23rd. Gentlemen holding official positions in the Universities, Colleges, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.

THE CHEMICAL NEWS.

VOL. XLIV. No. 1139.

ADDRESS TO STUDENTS.

Now our colleges and scientific schools are resuming their duties, we feel called upon again to make a few remarks for the special consideration of the student. We would above all ask him what is his especial object in seeking an acquaintance with chemical science? He may regard it as a subject of which in these days no man of culture can well afford to be entirely ignorant, and with this view he may seek to gain a clear and accurate, though of course summary, knowledge of its leading facts, of the thories in which they are embodied, and of their practical applications. Such a knowledge of principles he will find of great value in almost every capacity or station of life, and we bid him therefore go on and prosper.

A second student may carry the same idea somewhat further. Wishing to acquire a thorough mental training, he may devote a portion of his time to chemistry, not so much for the especial value of the facts or the laws which it teaches as for the discipline it conveys. We know that the advocates of an exclusively classical and mathematical education admitted that the value of their favourite studies lay less in *doctrine* than in *method*. But chemistry, if rightly studied, gives a kind of mental training which classics and mathematics cannot impart. It teaches the art of minute and accurate observation; it fixes the mind upon facts rather than upon words; it instructs us in the experimental examination of Nature. To all who view chemical science in this light, as one of the most important agents in intellectual culture, we would address a word of encouragement. If they persevere they will assuredly never regret the hours they have spent in the laboratory. It must be distinctly understood, however, that we refer here to actual work. No book studies, no paper training, will convey the arts of observing and experimenting.

We come now to the noblest type of the student. There are men, unhappily too few, endowed with exceptional mental powers, and with a natural love for science quite irrespective of any outward results in the shape of emoluments or honours. If such persons are willing to devote their lives to discovery, and possessing a competence are not liable to have their time wasted by the exigencies of a profession or business, they may find in the pursuit of chemistry a field for their talents, not merely fruitful but inexhaustible. It is not merely for the honour but for the actual benefit of this country, and of the whole human race, that we wish this class of students to be multiplied. To all who combine the various qualifications needful, we would say: give your lives to research!

We come now to students who enter the laboratory with a professional or practical intention, having an eye mainly to the actual or possible applications of chemical science. Of such there are two distinct classes. There are many who look forward to employment in some of the many arts and manufactures which are more or less exclusively based upon chemical principles, such as metallurgy, glass-making, dyeing, tissue-printing, colour-making, bleaching, the manufacture of alkali, &c. For all such a scientific knowledge of chemistry is essential as a foundation. The day is over when a bundle of receipts and the possession of a few trade secrets could make either a master, a manager, or a foreman equal to the duties required of him. Before we can rationally teach applications we must lay down principles. Otherwise our knowledge will be mere empiricism, very good, doubtless, under some particular set of circumstances, but utterly useless the moment any new and unexpected contingency arises.

But there is another class of students who start with a practical aim whom we must bid pause and reflect. We refer to those who, without being prospectively connected with any of the chemical industries, would follow chemistry as a profession, and become "analytical and consulting chemists." We would warn such students that this profession is over-crowded and ill-remunerated, and that to its most distinguished and successful members it brings nothing like the rewards which fall to the lot of the lawyer, the engineer, or even of the medical practitioner. We would therefore bid all students of this class to consider whether they possess the necessary qualifications, bodily as well as mental, and whether they have the means for their support during the years which must pass before they can acquire a connection. In any case we would advise such, after the completion of their college course to seek a practical acquaintance with some of the chemical arts. Some eminent authorities, indeed, would invert the arrangement, and advise a young man to work for two or three years—*e.g.*, in the dye-house—before beginning his college training.

There is, last in rank and value, but certainly not least in numbers, s class of students who care nothing for chemistry as a mental discipline—who would not if they could, and could not if they would, devote themselves to research, and who have just as little sympathy or connection with the chemical arts. The object of these worthies is to pass some examination. Chemistry is one of the subjects to be "got up," and is of course regarded as a necessary evil, or in the language of the class in question, as an "awful bore." What can we say to such? We can give them neither advice nor encouragement, and can only regret the institutions which render them possible.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 9th, 1882. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the

following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Papers in Latin and Greek will contain passages to be translated into English, with questions in Grammar and History and Geography arising out of the subjects of the books selected. Short and easy passages will also be set for translation from other books not so selected. A separate paper will be set containing questions in Latin Grammar, with simple and easy sentences of English to be translated into Latin.

Candidates may substitute German for Greek.

The papers in French and German will contain passages for translation into English, and questions in Grammar, limited to the Accidence. The paper in Sanskrit or Arabic will contain passages for translation into English, and questions in Grammar.

The examination in the English Language, English History, and Modern Geography includes Orthography; Writing from Dictation; the Grammatical Structure of the Language. History of England to the end of the Seventeenth Century, with questions in modern Geography.

That in Mathematics includes the ordinary Rules of Arithmetic; Vulgar and Decimal Fractions; Extraction of the Square Root. Addition, Subtraction, Multiplication, and Division of Algebraical Quantities; Proportion; Arithmetical and Geometrical Progression; Simple Equations. The First Four Books of Euclid, or the subjects thereof.

The Questions in Natural Philosophy are of a strictly elementary character; they include Mechanics, Hydrostatics, Hydraulics, Pneumatics, Optics, and Heat.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the First LL.B. Examination, or at the Preliminary Scientific and First M.B. Examinations, within three academical years* from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the First B.A. or to the First B.Sc. Examination in the following July.

First B.Sc. Examination.

The First B.Sc. Examination will be held in July, 1882.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the First B.Sc. Examination in all its subjects may be examined at the Honours Examination next following the First B.Sc. Examination at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the First B.A. Examination, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the first B.Sc. Examination, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday (with Saturday if necessary) in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

Second B.Sc. Examination.

The Second B.Sc. Examination will be held in October, 1882.

Candidates for this Examination are required to have passed the First B.Sc. Examination at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the Second B.Sc. Examination, and has not previously passed the Second B.A. Examination, may be examined at the Honours Examination next following the Second B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the

* By the term "Academical Year" is ordinarily meant the period intervening between any Examination and an Examination of a higher grade in the following year; which period may be either more or less than a Calendar year. Thus the interval between the *First* Examinations in Arts, Science, and Medicine, and the *Second* Examinations of the next year in those Faculties respectively, is about sixteen months, whilst the interval between the Second B.A. Examination and the M.A. Examination of the nex tyear, or between the Second B.Sc. Examination and the D.Sc. Examination of the next year, is less than eight months. Nevertheless, each of these intervals is counted as an "Academical Year."

corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the Second B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the Second B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

Doctor of Science.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the Second B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the first B.Sc. Examination, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

Branch IV. of Physical Science. Inorganic Chemistry.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

Branch V., Organic Chemistry.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

Preliminary Scientific (M.B.) Examination.

This examination will be held in July, 1882.

No Candidate is admitted to this examination until he has completed his seventeenth year, and has either passed the Matriculation Examination* or taken a Degree in Arts in one of the Universities of Sydney, Melbourne, Calcutta, or Madras (provided that Latin was one of the subjects in which he passed). The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative Analysis.

Examination in Subjects relating to Public Health.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

Candidates are examined in the following subjects:—

Chemistry and Microscopy, in relation to the examination of Air, Water, and Food.

Meteorology and Geology, as far as they bear on the duties of Health Officers, viz.:—General knowledge of Meteorological Conditions; Reading and Correction of Instruments. General knowledge of Rocks; their Conformation and Chemical Composition, and their relation to underground Water, and to drainage and sources of Water-supply.

Physics and Sanitary Apparatus.—The laws of Heat Mechanics, Pneumatics, Hydrostatics, and Hydraulics, in relation (or sanitary purposes) to the construction of Dwellings, and to the principles of Warming, Ventilation, Drainage, and Water-supply, and to forms of apparatus for these and other sanitary uses. And the reading of Plans, Sections, Scales, &c., in regard to sanitary constructions and appliances.

Vital Statistics, in reference to the methods employed for determining the Health of a Community; Birth-rate; Death-rate; Disease-rate; Life-Tables; Duration of and Expectancy of Life. Present amount of Mortality, and its causes, in different Communities. Practical statistics of Armies, Navies, Civil Professions, Asylums, Hospitals, Dispensaries, Lying-in Establishments, Prisons, In-door and Out-door Paupers, Friendly Societies, Sick-Clubs, Medical and Surgical Practice, Towns.

Hygiene, including the Causation and Prevention of Disease.

Sanitary Law, as far as it relates to the duties of Officer of Health. A knowledge of the powers given under the various Sanitary Acts, as defined in the Instructions issued by the Local Government Board, and of the methods of procedure in special cases.

The Examination, which is both written and practical, extends over four days.

Gilchrist Scholarships.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the First B Sc. Examination, or who have previously passed the First B.A. Examination, are admissible to the Second B Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination, admits a Candidate to the First B.Sc. Mathematics also, *if taken at the same time.*

among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom. The object of the grant is to promote instruction in Science, especially among the industrial classes, by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools.

In order to place a science school in connection with the Science and Art Department, an approved committee, consisting of at least five well known and responsible persons, must be formed.

The following are the sciences towards instruction in which aid is given by the Science and Art Department:—Practical, Plane, and Solid Geometry; Machine Construction and Drawing; Building Construction; Naval Architecture and Drawing; Pure Mathematics; Theoretical Mechanics; Applied Mechanics; Sound, Light, and Heat; Magnetism and Electricity; Inorganic Chemistry; Organic Chemistry; Geology; Mineralogy; Animal Physiology; Elementary Botany; Biology, including Animal and Vegetable Morphology and Physiology; Principles of Mining; Metallurgy; Navigation; Nautical Astronomy; Steam; Physiography; Principles of Agriculture.

The aid is given in the form of—1. Public examinations in which Queen's Prizes are awarded, held at all places, complying with certain conditions; 2. Payments on the results of examination and on attendance; 3. Scholarships and Exhibitions; 4. Building grants; 5. Grants towards the purchase of apparatus, &c.; 6. Supplementary grants in certain subjects, and special aid to teachers and students.

The examinations are held about the month of May under the superintendence of the local committees and local officers. The examination papers are prepared by the professional examiners in London, and the examination in each subject is held simultaneously over the whole kingdom.

A packet of examination papers is sent to a specially appointed custodian, and the superintendents of the examination open it in the presence of the candidates. The superintendents are responsible that no unfair means of any description are used in working the papers, and that the rules of the Department are strictly complied with.

The subjects are divided into three stages, and a separate set of questions is set in each. In each stage—Elementary, Advanced, and Honours—there are two grades of success, 1st and 2nd Class. The Elementary and Advanced stages are for the ordinary Science Schools. The Honours examination is of a very advanced character.

Any person however taught may sit at any one of these examinations.

Queen's prizes, consisting of books or instruments, are given to all candidates who are successful in obtaining a first class in either the elementary or the advanced stage, and Bronze Medals to those who obtain a first class in Honours.

Payments are made on the results of the May examination on account of the instruction of students of the industrial classes, or of their children. The payments are—£2 for a first class, and £1 for a second class, in the elementary and in the advanced stage, and £2 and £4 for a second or first class respectively in honours. Extra payments are made for attendance in Organised Science Schools. Special payments are also made for practical Chemistry. The teacher must have given at least 28 lessons to the class and each student must have received 20 lessons at least.

There are also two forms of scholarship in connection with elementary schools.

a. In the Elementary School Scholarship £5 are granted to the managers of any elementary school for the support of a deserving pupil selected by competition, if they undertake to support him for a year and subscribe £5 for that purpose. The payment of £5 by the Science and Art Department is conditional on the scholar passing in some branch of science at the next May examination.

b. In the Science and Art Scholarship, which is of a more advanced character, a similar contribution of £5 is required on the part of the locality, and a grant of £10 is made by the Department towards the maintenance, for one year, of the most successful pupil or pupils in elementary schools who have passed certain examinations in science and in drawing.

In the first case the scholar must be from twelve to sixteen, and in the latter from twelve to seventeen years of age. One scholarship is allowed per 100 pupils in the school. Thus a school with 50 pupils may have one scholarship, a school with 150 pupils two scholarships.

There are also two forms of Exhibitions. These are:—

a. Local Exhibitions to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained. Grants of £25 per annum, for one, two, or three years are made for this purpose when the locality raises a like sum by voluntary subscriptions. And if the student attend a State School, such as the Royal School of Mines in London, the Royal College of Chemistry in London, or Royal College of Science in Ireland, the fees are remitted. The exhibition must be awarded in competition.

b. Royal Exhibitions of the value of £50 per annum tenable for three years, to the Royal School of Mines, London, and the Royal College of Science, Dublin, are given in competition at the May examinations. Six are awarded each year—three to each institution. The exhibitions entitle the holder to free admissions to all the Lectures, and to the Chemical and Metallurgical Laboratories at those two institutions.

The competition for the Whitworth Scholarships, tenable for three years, is also in part determined by the results of the May examinations.

A grant in aid of a new building, or for the adaptation of an existing building, for a School of Science may be made at a rate not exceeding 2s. 6d. per square foot of internal area, up to a maximum of £500 for any one school, provided that certain conditions are complied with and that the school be built under the Public Libraries and Museums Act, or be built in connection with a School of Art, aided by a Department building grant.

A grant towards the purchase of fittings, apparatus, diagrams, &c., of 50 per cent of the cost of them is made to Science Schools.

Special extra grants in the form of capitation payments are made in fully organised Science Schools.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

Demonstrators.—J. W. Hicks, M.A., W. J. Sell, B.A., and H. J. H. Fenton, B.A.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators nteatddaily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:—

Michaelmas Term, 1881.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 13.

Physical Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 14.

Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 15.

Metals, by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 14.

General Principles of Chemistry, by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 17.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Oct. 14.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 1.30 p.m. Begin Oct. 18.

Analysis, by the Professor and the Demonstrators of Chemistry. Also at St. John's, Caius, Sidney, and Downing Colleges. Daily. Begin Oct. 13.

Lent Term, 1882.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Feb. 2.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Feb. 3.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Feb. 2.

Non-metallic Elements, by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Feb. 1.

Organic Chemistry, by Mr. Walker, at Sidney College, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Feb. 1.

General Principles of Chemistry continued, by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Feb. 2.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Feb. 1.

Analysis, at the University Laboratory, daily. Begin Jan. 19. And at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 30.

Easter Term, 1882.

Some Special Department, by the Professor of Chemistry, on Tuesdays and Saturdays, at 12 noon. Begin May 3.

Elementary Chemistry, by a Demonstrator, on Mondays, Wednesdays, and Fridays, at 3 p.m. Begin April 24.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin April 25.

Elementary Organic Chemistry, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 26.

Catechetical Lectures, by Mr. Walker, at Sidney College, on Mondays, Wednesdays, and Fridays, at 12 noon, and by Mr. Lewis, at Downing College, same days, at 9 a.m. Begin April 24.

Analysis, at the University Laboratory, daily. Begin April 25. Also at St. John's College. Begin May 2. Also at Caius College. Begin April 20. Also at Sidney College. Begin April 27.

UNIVERSITY OF DUBLIN.—TRINITY COLLEGE.

The University Professor of Chemistry, Dr. Emerson Reynolds, F.R.S., assisted by the Demonstrator of Chemistry, Mr. Early, conducts the undermentioned Courses of Laboratory instruction:—

The First Course of Practical Chemistry.—Michaelmas Term:—Qualitative Analysis and the Use of the Spectroscope. Hilary Term: Volumetric and Simple Gravimetric Analysis. Trinity Term: Organic Preparations and Analysis.

Students can also attend the Professor's Lectures on General Chemistry, and repeat most of the experiments performed in the Theatre.

The Second or Advanced Course includes instruction in the higher branches of Experimental and Analytical Chemistry, and in Methods of Research. Students who take out this Course are free to devote their chief attention to the study of special departments of Chemistry as applied to Arts and Industries.

Summer Course of Practical Chemistry for Medical Students.—This Course commences on the first Monday in April and terminates on the 30th of June following. Students experiment in the Laboratory from 2 to 4 o'clock on Tuesdays, Thursdays, and Saturdays.

Special Courses.—Students can enter at any time throughout the academic year for short terms of Laboratory instruction in Medical or Pharmaceutical Chemistry, or in the Methods of Analyses of Water, Air, &c., for Sanitary Purposes.

Lectures in Medical and Pharmaceutical Chemistry.—Dr. Reynolds lectures at 2 o'clock on Tuesdays, Thursdays, and Saturdays, from the 1st of November to the 31st of March following.

All the classes are open to extra-Academic Students.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at interval during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1881-82, are Tuesday, October 4, Wednesday, January 11, and Wednesday, April 19.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. GENERAL COURSE.

Lectures daily (except Saturday) from 11 to 12 a.m., up to the last week in March.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m. First Meeting, October 6, 1881.

Fees for the Course, £7 7s.; Perpetual, £9 9s.; for the Half Course, £4 4s.; for the Organic Course alone, £2 2s.

Fee for the Exercise Class, £2 2s.

The instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by an Assistant.

Attendance on the Exercise Class (conducted by Mr. Temple A. Orme, F.C.S.) enables Students to do their work more effectually and rapidly than they can do it by themselves.

A. *The first half* of the course, to Christmas, includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

B. *The second half* of the Course, from January to March, includes the following subjects:—

1. Preparation and properties of the chief *Metals*, including their characteristic reactions and most important salts. Detection of metallic poisons. Quantitative estimation of metals. Principles of classification. Monatomic, diatomic metals, &c.

Organic Chemistry commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring-matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Training of Teachers.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

The first year is occupied with attendance on the Courses of Chemistry and of Analytical Chemistry. In the second year the Student again attends the Course of Chemistry, and is intrusted with teaching-work in conjunction with the Tutors of the class. At the same time he continues to work in the Laboratory at analysis and original research.

In order to qualify themselves for rising to the higher ranks of the Profession, gentlemen remain for a further period, in which case they may obtain remunerative work in teaching through the recommendation of the Professor.

It must not, however, be supposed that a study of Chemistry alone, however complete, is sufficient to qualify a man to teach the Science effectively. A competent knowledge of Physics, Mathematics, and either French or German must necessarily be acquired at some period of the Student's Course.

II.—ANALYTICAL AND PRACTICAL CHEMISTRY.

A. *Birkbeck Laboratory.*

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c.

Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

B.—Summer Practical Courses.

Chemical Theatre.

1. *Elementary Course.* (*Men.*)—About Forty Lessons of one hour each, commencing in the first week of May.; The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied.

Fees—including the cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

2. *Senior Course.* (*Men.*)—This Course consists of Twenty Lessons of two hours each, commencing in the first week in May.

The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerin, alkaloids, &c.

The second half of the Course includes tests for mineral poisons in organic mixtures; also tests for organic bodies, such as alkaloids, when mixed with other organic substances.

Volumetric methods of the quantitative analysis of sugar and urea, chlorides, phosphates, hardness of water, alkalimetry, are practised.

Analysis of milk and ashes of blood.

Fees—including cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

III.—Summer Matriculation Course. (*Men.*)

Temple A. Orme, F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. These lessons will begin on March 21, 1882, at 11.

Fee, including cost of materials and apparatus, £4 4s.

Elementary Chemistry.

Chemical Theatre. (*Women*).

Lectures—Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Winter Session, commencing Wednesday, October 13.

The instruction will consist partly of Lectures, partly of Laboratory Experiments performed by the Students.

Fees for the Course, including use of apparatus and materials, £4 4s.

Chemical Technology.

Professor Charles Graham, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

Assuming that the Student enters for a three years' study, the following will give an idea of the nature of the work during the period:—

In the first year the Student will attend Lectures on Theoretical Chemistry, and work at Analytical Chemistry in the Chemical Laboratory, and will also attend Lectures on Mathematics, Mechanics, and Physics. The Mechanical Drawing Class should also be attended during the first year by all Students.

In the second year, the Student will again attend the Lectures on Theoretical Chemistry, also practical work in the Chemical and Physical Laboratories, and Lectures on Mineralogy and Geology.

The third year will also be chiefly occupied with attendance on the Lectures on Chemical Technology, and in practical work connected therewith in the Laboratory, and, during the Summer Term, Lectures on Botany.

The Student will, in addition to the foregoing subjects, which are common to all, attend Lectures and work at such other branches of Pure and Applied Science as may be deemed advisable after consultation with the Professor.

Students entering the College with more advanced scientific knowledge will be able to shorten the Course described to two years, or even one year, as may be found advisable.

For the convenience of those already engaged in business, and of those from other causes prevented from entering for a longer period of study, it is arranged that they can attend the Laboratory of Chemical Technology or a Course of Lectures upon any one subject of Applied Chemistry without being required to attend any other lectures, either in Applied Chemistry or in other subjects.

In the Session 1882-83, it is proposed to treat of the following subjects:—

(1) The Chemistry of the Alkali trade.
(2) Soap, Glass, Pottery, Cements.
(3) Agricultural Chemistry.
(4) Distilling, Vinegar-making, or the Chemistry of Brewing.

Should a sufficient number of Students desire a Course of Lectures on some subject of Applied Chemistry other than those above mentioned, the Professor will give such either in lieu of, or in addition to, those mentioned.

Students desirous of working at subjects not included in the foregoing Courses, such as Photography and Photographic materials, Paper-making, Gas-tar products, the products of the Distillation of Wood, Tanning, and other Chemical industries, will receive individual instruction in the Laboratory.

Fees—for each Course, £2 2s.; for the four Courses together, £5 5s.

Chemical Laboratory.

The instruction in the Laboratory in Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professors.—Dr. H. E. Roscoe, F.R.S., and Dr. W. J. Russell, F.R.S.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. Other students are admitted so far as there may be accommodation for them, on the payment

of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he select for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.
	£	£	£	£
Chemistry	5	16	18	18	
Physics	5	12	16	16	
Biology with Botany	4	8	8	4	8
Geology with Mineralogy ..	4	8	12		
Mechanics	4	6	10	10	
Metallurgy	2	16	18		
Assaying for Mining Students		12			
Mining	4	12			
Agriculture	4	10			
Astronomy	3				

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to £75, and for the remainder of the course for the Associateship they vary from £30 to £40.

Both the private, and the State-aided, students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the Chemical and Metallurgical, and Physical laboratories are £5 per month; for the Biological and Geological laboratories £4 per month.

Admission is granted to persons desirous of attending the lectures without the laboratory instruction, on payment of the lecture fees.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who have passsed in the advanced stage, or in honours, in any subject in the May examination of the Science and Art Department, or in the December examination in Training Colleges, may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given aunually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them and they receive 2nd class railway fare to and from London, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Mén's Lectures.—Three or four courses of evening lectures for working men are given annually during the winter months by the Professors and Lecturers of the Normal School and the School of Mines. The admission to each course of six lectures, which will be given at South Kensington, Jermyn Street, or Bethnal Green, is 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY OF ABERDEEN.

Professor of Chemistry.—J. S. Brazier, F.C.S.

I. *Systematic Course.*—The Lectures are delivered on the first five days of each week during the College session. They commence with the discussion of the General Principles of Chemical Philosophy, including the Atomic Theory and the Chemical Relations of Heat. The Non-metallic and Metallic Elements and their Compounds are fully treated of, together with their more important applications to the Arts. The latter part of the course is devoted to the subject of Organic Chemistry. Examinations are held at fixed periods during the Session. The fee is £3 3s.

II. *Practical Course.*—This course is given during the Summer Session. It is chiefly devoted to practice in Qualitative Analysis, with the view of enabling the Student to test unknown substances, poisons, the animal secretions, &c. The fee is £3 3s.

III. *Laboratory Pupils.*—The Chemical Laboratory is open during the College Session on the first five days in each week, from 10 a.m. till 3 p.m. The course of instruction is under the direction of the Professor of Chemistry and of the Teaching Assistant.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—Adrian Blaikie, D.Sc.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 10 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms; the last of these being a tutorial lecture, which will deal with points requiring detailed explanation.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Technical Chemistry.

Lectures will be given during the First and Second Terms on Thursdays at 11, on Manufacturing and

Metallurgical Processes with which Chemistry has specially to deal.

Fee, £2 2s. for two Terms, £1 5s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	Whole Day.			Half Day.	
	6 Days a Week.	3 Days a Week.	2 Days a Week.	6 Days a Week.	3 Days a Week.
Per Session	18	10	7½	12	7
„ Two Terms ..	13	7½	5½	8½	5
„ One Term ..	7	4	3	4½	3
„ Month	3	2	1½		

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

Evening Lectures.

Lecturer.—Adrian Blaikie, D.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Study of the chief Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of Metals. In treating of the various products under the latter heading special attention will be devoted to those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Evening Course of Practical Chemistry.

Professor.—W. Ramsay, Ph.D.

Tuesday and Thursday, 7 to 9.

A Practical Class will be formed for instruction in Qualitative and Quantitative Analysis. The Fee for the course (extending over the first and second terms) will be £3 3s. for two terms. £2 2s. for one term, and no additional charge will be made for reagents or apparatus, provided the latter be returned undamaged.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

All particulars may be learned by application to J. N. Langley, LL.D., Registrar and Secretary.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—C. Rawson, F.C.S., and Mr. W. James.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the general study of Chemistry of inorganic bodies, and of the more frequently occurring bodies of organic origin, and, finally, the Chemistry of the atmosphere, of soils and manures, vegetation, animal nutrition and cattle feeding, and of Agricultural economy.

In the Laboratory practical instruction is given in Chemical manipulation and analysis, both qualitative and quantitative. The Students, on entering, are provided with a set of Chemical Apparatus, and after studying the properties of the more commonly occurring substances, are taught to analyse a series of compounds, proceeding from simple to mose complex cases, and apply the knowledge thus obtained to the analysis of manures, soils, waters, ashes of plants, foods and feeding stuffs, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry—Monday, Tuesday, Wednesday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculations—Wednesday, at 10 a.m., during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12, during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Thursdays, at 8 p.m., beginning October 13. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 10. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Goodall Exhibition of £10, tenable for one year, will be awarded to the candidate who shall take the second place in the competition for the Salt Scholarship.

The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

LIVERPOOL COLLEGE OF CHEMISTRY.

Lecturers.—George Tate, Ph.D., F.C.S., and Granville H. Sharpe, F.C.S.

Day Courses.—A course of 100 lectures on Inorganic and Organic Chemistry on Mondays, Tuesdays, Thursdays, and Fridays, at 3, commencing October 7th and ending in May, by Dr. Tate.

The subjects embraced will be those required for the chemical examinations of London (2nd B.Sc. and 1st M.B.). Fee £4 4s.

A course of thirty lectures on the Alkali Manufacture on Saturdays, at 3, by Mr. Sharpe.

A course of thirty lectures on the Metallurgy of Iron, Copper, Tin, and Zinc, on Saturdays, at 4, by Dr. Tate.

In the summer term free courses will be held on :—

The Manufacture and Application of Chemical Manures, by Mr. Sharpe.

Technical Organic Chemistry (Sugar refining, Brewing, Tanning, Dyeing, &c.), by Dr. Tate.

The laboratories are open daily throughout the year. Fee for the full laboratory course of three months £10 10s., or six hours weekly £3 3s.

Special practical courses are arranged for Brewery pupils.

Evening lectures and practical courses are held on Mineralogy, Geology, Chemistry, and Physics.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—A. Freire-Marreco, M.A. *Demonstrator*—J. T. Dunn, B.Sc.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Elements of Organic Chemistry. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry, including Chemical Mineralogy and Analysis.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Arrangements for Laboratory work in the evening and during vacation will be made.

The Session will commence on October 3.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations :—

1. Durham Senior Examination of Persons not Members of the University, held in June.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises :—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises :—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must pass the entrance examination, and will, in addition, be examined in the following subjects :—Algebra, up to Quadratic Equations. Euclid, Books I., II., and III. And one of the following special subjects, to be selected by the Candidate :—Geology.—Text Book: Page's "Introductory Text Book." Heat.—Text Book: "Orme on Heat." Chemistry.—Text Book: Gill's "Chemistry for Schools," omitting chapters xiii., xvi., xx., and xxi. Natural History.—Text Book: Nicholson's "Elementary Text Book of Zoology," or Oliver's "Elementary Botany," Part I.

Candidates must send their names to the Secretary, on or before the 25th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 3rd October.

Two similar Exhibitions will be awarded at the next examination of 'Persons not members of the University," which will be held at Durham, and elsewhere, in June next, to those candidates who shall most distinguish themselves in subjects allied to Physical Science.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Mr. W. C. Williams, F.C.S., P. P. Bedson, D.Sc., and Watson Smith, F.C.S.

The Session begins on October 4, 1881, and ends on June 23, 1882.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior and Tutorial classes. Chemical Laboratory, 2 days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics or Geology. French or German. Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior,* Senior, and Tutorial classes. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures. German or French. Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior and Tutorial classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, 3 days per week. Technological Chemistry. Physical Laboratory, 1 day per week, or Practical Mineralogy and Technological Mineralogy. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry. Chemical Laboratory, 4 days per week. Chemistry of Colouring-Matters, Dyeing, and Calico-Printing (4th evening course). Mechanical Drawing, Practical (evening class).

Fees.—First year (including College Admission and Library fees), £26 19s. 6d.; second year, £28; third year, £28 10s. 6d.; fourth year, £23 19s. 6d.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15. Renewable for a second year.

IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspere Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. Hill Smith.

Inorganic Chemistry.

A systematic course of about twenty lectures on the non-metallic elements will be delivered on Tuesday and

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

Thursday mornings. A tutorial class follows one lecture every week. The fee for the lecture course is one guinea, the inaugural lecture being free.

An evening course of eleven lectures on the same branch of chemistry will be delivered on Wednesdays; each lecture to be preceded by a tutorial class. Fee for lectures 3s. 6d.; for lectures and classes 5s. The first lecture will be free.

Practical and Technical Chemistry.

The chemical laboratory will be open on Monday, Wednesday, and Friday mornings, and at other times by arrangement with the Professor. Fee for one attendance per week one guinea.

An evening laboratory class will also meet every Tuesday evening. Fee, 10s. 6d., or 5s. for working men daily engaged in occupations involving the applications of chemistry.

Full information can be obtained by application to the Secretary at the College.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry and Experimental Physics.—T. Carnelley, D.Sc.

The Session will commence on Tuesday, October 4, 1881.

First Year's Course.—Chemistry of the Non-Metallic Elements. Tuesday, Thursday, Saturday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals: Organic Chemistry. Monday, Wednesday, Friday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students. Students proposing to work six days a week can be entered for periods of one, two, or three months on payment of a certain proportion of the Sessional Fees, which are—For six days a week, £18 18s.; four, £14 14s.; three, £10 10s.; two, £7 10s. 6d.; one, £4 4s. Fees for short periods:—For one month, £3 13s. 6d.; two months, £6 6s.; three, £9 9s.; four, £12 1s. 6d.; five, £14 3s. 6d.

Evening Classes.—Lecture, Tuesday, 7 to 8; Class, 8 to 9. Fee, 5s. per term, or 9s. per two terms. Laboratory instruction, Wednesday, 7 to 9. Sessional Fee, £2 2s. (Students joining the laboratory at Christmas will be charged half the fee for the whole Session).

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 25, 1881.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects, Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.
Chief Assistant.—M. T. Buchanan.
Lecture Assistant.—John Lennox.
Junior Assistants.—R. N. Lennox, James M. Bowie, and John McArthur.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10 to 11, commencing about the end of October. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals (on the Mondays and Tuesdays) and Organic Chemistry, select chapters (on the Wednesdays, Thursdays, and Fridays). Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory for Practical Instruction in all branches of analysis, including technical assaying, and for original research is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturday also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.
Senior Assistant.—Mr. J. Snodgrass.
Junior Assistant.—Mr. J. Bicket.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Fifty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 7th. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. The earlier Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results. A particular subject will then be considered in comparatively minute detail, embracing for this session Dyeing and Printing.

Fee for the Course, Two Guineas. To Laboratory Students, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Technical Physical Chemistry.—Mr. J. Snodgrass, Senior Assistant, has arranged to deliver a series of Thirty Lectures and Demonstrations on Physico-Chemical Measurements.

Fee for the Course, Half-a-Guinea. Laboratory Students, Half-a-crown.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories for Technical Research.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the opinion of the Trustees, unworthy of their position. The Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on October 3, 1881.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction. tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—A Course of about ten Lectures on Organic Chemistry will be given by Prof. Hartley on Fridays, at 8. Fee, 5s.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education, Cowper Street, Finsbury.—Session commences October 4, 1881. Day and Evening Lectures and Laboratory instruction. Technical Chemistry, Prof. H. E. Armstrong, Ph.D., F.R.S. Technical Physics, Prof. W. E. Ayrton, F.R.S.

City of London College, 52, Leadenhall Street, E.C. —Chemical Lecturer—Dr. A. C. Maybury. The courses of lectures are as follows:—

Elementary Electricity	Mondays,	6.30—7.30.
Elementary Chemistry	,,	7.30—8.30.

The Session will commence on Monday, October 3. Fee, 6s. per term; per session, 15s.

These classes are specially arranged for Students preparing for the Science and Art Department Examinations, Matriculation, Chemists' Assistants, Teachers, &c.

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Charterhouse Institution.—The Session commences September 24, under the presidency of the Rev. Henry Swann, M.A, Lectures and Practical Work in a well-fitted laboratory capable of holding 60 students.

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Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane. — Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.30 to 9.30; Advanced, Saturdays, 7 to 8. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 4th. Practical Organic Chemistry:—This Class will meet in the Laboratory of the Institution, under Mr. Chapman Jones's direction, on Saturdays from 4 to 6 and from 8 to 10 p.m.

New Central School of Chemistry and Pharmacy, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Physical Laboratory is open every evening for practical work from 7 to 10 p.m.

South West London Central School of Chemistry and Pharmacy, 183, King's Road, Chelsea.—Daily Lectures by Mr. W. H. Martin.

Royal Veterinary College, Camden Town.—Professor of Chemistry, Mr. R. V. Tuson.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 3rd of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment, synthetical as well as analytical. They are specially designed for the student of Pharmacy, but are also well adapted for the acquirements of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, the Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session only.

South London School of Chemistry, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Sixty Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

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Leeds School of Medicine.—Prof. T. E. Thorpe, Ph.D., F.R.S.

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Sheffield School of Medicine.—Mr. A. H. Allen, F.C.S. A course of Lectures on Inorganic and Organic Chemistry is delivered by Mr. Alfred H. Allen during the Winter session. The Summer Course of Practical Chemistry is under the direction of Mr. A. H. Allen.

Sheffield Borough Analysts' Laboratory, 1 and 3, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

Wesley College, Sheffield.—Lectures on Chemistry, Natural Philosophy, and Natural Science by the Rev. W. H. Dallinger, F.R.S.

Aberdeen School of Science and Art Mechanics' Institution.—Mr. Thomas Jamieson, F.C.S.

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Glasgow Veterinary College.—Mr. Stephen Cooke, F.C.S.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

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CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 4, July 25, 1881.

Hydrochloric Ether of Glycol.—M. Berthelot.—Glycolic ether has a greater tendency to combine with acids forming compound ethers than has glycol, or than have the simple ethers of the monatomic alcohols. Hence in certain respects it may be approximated to the bases properly so-called.

On Hemihedral Crystals with Inclined Surfaces, as Constant Sources of Electricity.—MM. Jacques and Pierre Curie.—A section suitably cut in a hemihedral crystal with inclined surfaces, and placed between two leaves of tin, constitutes a condenser which is capable of charging itself when compressed. With this system we may realise a new instrument, a condenser source, which possesses special properties. It may serve as a standard of static electricity for measuring charges and capacities. The authors give in this memoir an absolute measurement of the quantities of electricity liberated by tourmaline and quartz under a given pressure.

Determination of the Angular Distance of Colours. A. Rosenstiehl.—The projection of a table of colours upon the sides of an equilateral triangle renders it possible to determine the exact angular distance of the colours, a result which has not yet been obtained, and which suffices to connect together the facts at present known. The author gives a diagram representing the law of the mixture of colours, and which will be advantageously substituted for Newton's rule.

Electric tap: the Transformation, Transportation, and Use of Energy.—G. Cabanellas.—This paper is inserted at length.

Formation-heat of Explosives.—MM. Sarran and Veille.—The authors describe their manner of experimenting, and promise to give their results in a future memoir.

The Magnesia Industry.—If we cause a solution of magnesium chloride to be absorbed by dry slacked lime, the magnesia set at liberty plays the part of a cement, and the matter may be moulded into small porous fragments. If one of these fragments is suspended in a solution of magnesium chloride after some days the lime is entirely substituted by hydrate of magnesia. The fragment has been the seat of a double diffusion; the magnesium chloride has diffused itself from without to within, and is changed in the fragment into calcium chloride, which in turn becomes diffused from within to without. These two diffusions are simultaneous and come to an end when all the lime has been substituted by magnesia. Here, then, is a means of reducing into a small volume a precipitate which would have occupied the entire bulk of the solution, if the fragment of lime had been stirred up in it at first. The same phenomena are produced if a great number of such fragments are heaped up in a suitable vessel, where a solution of magnesia is made to circulate slowly from the top to the bottom. In five or six days the conversion is complete; the solution may be replaced by pure water, and the magnesia washed completely. On stirring up it becomes a white pulp, which, if dried in the air, gives a very friable mass. It is hydrated magnesia which may remain for a long time exposed to the air without becoming notably carbonated. Its purity depends on that of the lime employed. In working on the large scale the author uses a paste of lime, which he forces through a plate of metal pierced with small holes, so as to eliminate stones and unburnt pieces. If these "worms" fell upon the ground, or into water, they would at once return to their pasty state. He therefore receives them in a solution of magnesium chloride, where they become at once covered with a slender coating of magnesia, which consolidates them so well that they may be heaped up to the height of 1·50 metres, still leaving between them the interstices needful for the circulation of the liquid. The paste of lime should contain from 34 to 36 per cent of anhydrous lime. The solution of magnesian salt should contain from 25 grms. to 40 grms. of anhydrous magnesia per litre. The laws of diffusion laid down by Graham are here at fault. The acceleration of the phenomena, due to an increase of strength, is balanced by the resistance opposed by a more consistent deposit of magnesia. The presence of sodium chloride, always abundant in the water of salt marshes, is indifferent. Soluble sulphates must be removed by adding the water from a former operation, rich in calcium chloride, and allowing the calcium sulphate to settle, after which the clear liquor is run off for treatment.

Certain Reactions of Morphine and its Congeners.—E. Grimaux.—The author has treated morphine with formic aldehyd in presence of sulphuric acid, making use of morphine dissolved in glacial acetic acid, a few drops

of methylenic aceto-chlor-hydrin, and sulphuric acid in excess. He thus obtains a new base, which he is examining. All the ethers of morphine behave in a similar manner.

Boric Acid, its Existence in the Salt Lakes of the Modern Period and in Natural Saline Waters.—M. Dieulafait.—The author concludes that the boric acid existing in sedimentary deposits, always associated with saline substances, is derived from the spontaneous evaporation, at ordinary temperatures, of the waters of ancient seas.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 3, May 19, 1881.

System of Annular Magnetic Compensators for the Correction of the Compass.—M. Duchemen.—This system consists in the application of annular magnets in place of the straight magnetic bars generally employed for the correction of the compass on board iron ships.

The Faure Battery.—Speaking of experiments performed in the Hall of the Société d'Encouragement, the writer declares that it was impossible to conceal from the eyes of connoisseurs the rapid decline of the luminous, thermic, and dynamic powers of the apparatus. He denies that M. Faure has succeeded in augmenting the accumulating power of the apparatus of M. Plan é in the proportion of 1 to 40.

No. 4, May 26, 1881.

M. Paul Laurencin gives a description in full of the Nihilist bombs as used for the assassination of the late Emperor of Russia. The editor adds the remark that "if science merely served to realise inventions so criminal there would be little reason to boast of its progress."

True Chemistry (No. 3).—M. Maumené.—The author advances as new proofs of the importance of his theory the decomposition of mercury cyanide and the action of nitric acid upon metals.

No. 5, June 2, 1881.

M. Macagno has been experimenting upon the influence of atmospheric electricity upon the growth of the vine. A copper wire with a platinum point was plunged into the extremity of a branch bearing fruits, whilst another wire connected the origin of the branch with the soil. An increase of vegetation was distinct, the wood of the branches contained less potash than that of other branches, whilst the grapes contained more sugar and less acid.

MISCELLANEOUS.

The Technological Society.—This Society, which has been recently established at Peckham, will meet every Friday at 8 p.m. at the Goldsmith Road Mission (adjoining St. Chrysostom's Church, Hill Street). An introductory lecture on "The Arts and Sciences," will be delivered on Friday evening, September 30th, 1881, by Hugh Clements, F.S.Sc., M.S.A.

Relation between Temperature and the Rate of Chemical Action.—R. B. Warder.—The speed of the reaction,

$$C_2H_5.O.C_2H_3O + NaOH = NaC_2H_3O_2 + C_2H_5OH,$$

in dilute aqueous solution, has been observed at temperatures from 3·6° to 37·7° C. This series of determinations nearly agrees with the equilateral hyperbola,

$$(7·5+a)\ (62·5°-t) = 521·4,$$

where t is the temperature, and a expresses the number of gram-equivalents per litre which would (according to the theory of the action of mass) react upon each other per minute in a solution kept of normal strength. Further details are deferred.—*Journal of the American Chemical Society.*

New Solid Flame Burner.—We have received from Mr. Fletcher, of Warrington, a sample of a new pattern of his patent solid flame burner. Although very small it will readily boil 7 or 8 gallons of water, with the ordinary day-pressure of gas. It will, at full power, burn about 10 cubic feet of gas per hour, and will boil a quart of water in a light kettle in about six minutes, requiring for this about 1 cubic foot of gas. The flame is perfectly solid, with a brilliant green centre when at its full power, and is intensely hot, giving the highest duty ever obtained for the quantity of gas consumed. The tests, as reported in the *Proceedings* of the British Association of Gas Managers (1880), show a duty nearly double that obtained from an ordinary Bunsen, burning the same quantity of gas. The burner is an improvement on the previous patterns which have been so highly spoken of, and is peculiarly adapted for general domestic purposes. It is designed for the roughest and hardest work, retaining at the same time the high duty obtained from the original and more delicately made patterns, which were not so well fitted for rough usage and were more costly.

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1140.

ON THE SEPARATION OF HYDROCARBON OILS FROM FAT OILS.*

By ALFRED H. ALLEN, F.C.S., F.I.C.

The extensive production of various hydrocarbon oils suitable for lubricating purposes, together with their low price, has resulted in their being largely employed for the adulteration of animal and vegetable oils. The hydrocarbons most commonly employed for such purposes are:—

1. Oils produced by the distillation of *petroleum* and bituminous *shale*, having a density usually ranging between 0·870 and 0·915.
2. Oils produced by the distillation of common *rosin*, having a density of 0·965 and upwards.
3. Neutral *coal oil*: being the portion of the products of the distillation of coal-tar boiling about 200° C, and freed from phenols by treatment with soda.
4. *Solid paraffin*, used for the adulteration of bees'-wax and spermaceti, and employed in admixture with stearic acid for making candles.

The methods for the detection of hydrocarbon oils in fat oils are based on the *density* of the sample; the lowered *flashing* and *boiling-points*; the *fluorescent characters* of the oils of the first two classes; and the *incomplete saponification* of the oil by alkalies. The *taste* of the oil, and its *odour* on heating are also useful indications.

If undoubtedly fluorescent, an oil certainly contains a mixture of some hydrocarbon, but the converse is not strictly true, as the fluorescence of some varieties of mineral oil can be destroyed by chemical treatment, and in other cases fluorescence is wholly wanting. Still, by far the greater number of hydrocarbon oils employed for lubricating purposes are strongly fluorescent, and the remainder usually become so on treatment with an equal measure of strong sulphuric acid.

If strongly marked, the fluorescence of a hydrocarbon oil may be observed in presence of a very large proportion of fixed oil, but if any doubt exist the hydrocarbon oil may be isolated. As a rule, the fluorescence may be seen by holding a test-tube filled with the oil in a vertical position in front of a window, when a bluish "bloom" will be perceived on looking at the sides of the test-tube from above. A better method is to lay a glass rod, previously dipped in the oil, down on a table in front of a window, so that the oily end of the rod shall project over the edge and be seen against the dark back-ground of the floor. Another excellent plan is to make a thick streak of the oil on a piece of black-marble, or glass smoked at the back, and to place the streaked surface in a horizontal point in front of and at right angles to a well-lighted window.† Examined in this manner, a very slight fluorescence is readily perceptible. If at all turbid the oil should be filtered before applying the test, as the reflection of light from minute particles is apt to be mistaken for true fluorescence. In some cases, it is desirable to dilute the oil with ether, and examine the resultant liquid for fluorescence. An exceedingly small amount of mineral oil suffices to impart a strong blue fluorescence to ether.

The quantitative analysis of mixtures of fat oils with hydrocarbon oils has till recently been very uncertain, the published methods professing to solve the problem being for the most part of very limited applicability, and in some cases wholly untrustworthy.

When the hydrocarbon oil in admixture happens to be of comparatively low boiling-point, it may often be driven off by exposing the sample to a temperature of about 150° C., but the estimation thus effected is generally too low, and often quite untrustworthy.

When it is merely desired to estimate approximately the proportion of hydrocarbon oil present, and not to isolate it or examine its exact character, Kœttstorfer's titration-process may be used, as suggested by Messrs. Stoddart. But the best and most accurate method of detecting hydrocarbon oils in, and quantitatively separating them from, fat oils, is to saponify the sample, and then agitate the *aqueous solution* of the soap with ether.* On separating the ethereal layer and evaporating it at or below a steam heat the hydrocarbon oil is recovered in a state of purity.

Either caustic potash or soda may be employed for the saponification, but the former alkali is preferable, owing to its greater solubility in alcohol and the more fusible character of the soaps formed. A convenient proportion to work with consists of 5 grms. of the sample of oil, and 25 c.c. of a solution of caustic potash in methylated spirit, containing about 80 grms. of KHO per litre. Complete saponification may usually be effected by boiling down the mixture in a porcelain dish, with frequent stirring, until it froths strongly. In the case of butter, cod-liver oil, and other fats which undergo saponification with difficulty, it is preferable to precede this treatment by digestion of the mixture for half an hour at 100° C. in a closed bottle. After evaporating off the alcohol, the soap is dissolved in water, brought to a volume of 70 to 80 c.c., and agitated with ether. The ethereal solution is separated, washed with a little water and carefully evaporated. The agitation with ether must be repeated several times to effect a complete extraction of the hydrocarbon oil from the soap solution.

The foregoing process has been proved to be accurate on numerous mixtures of fat oils with hydrocarbon oils. The results obtained are correct to within about 1 per cent in all ordinary cases. In cases where extreme accuracy is desired, it is necessary to remember that most, if not all, animal and vegetable oils contain traces of matter wholly unacted on by alkalies. In certain cases, as butter and cod-liver oil, this consists largely of *cholesterin*, $C_{26}H_{44}O$.† The proportion of unsaponifiable matter soluble in ether which is naturally present in fixed oils and fats rarely exceeds 1½ per cent, and is usually much less. Sperm oil, however, constitutes an exception, yielding by the process about 40 per cent of matter soluble in ether.‡ This peculiarity has no practical effect on the applicability of the process, as sperm oil, being the most valuable of commercial fixed oils, is never present without due acknowledgment of the fact. Spermaceti and the other waxes yield, after saponification, large percentages of matter to ether, and hence the process is not available for the determination of paraffin wax in admixture with these bodies, though it gives accurate results with the mixtures of paraffin and stearic acid so largely employed for making candles.

The following figures obtained in my laboratory by the analysis of substances of known purity and of mixtures of known composition, show the accuracy of which the pro-

* A Paper read before the Chemical Section of the British Association, York Meeting, 1881.

† Either of these plans is infinitely superior to the polished tin-plate usually recommended. In short, the back-ground should be black, not white.

* According to my experience, treatment of the *dry* soap with ether, petroleum spirit, or other solvent, is liable to cause error from solution of the soap itself, if much hydrocarbon oil be present.

† The process affords a very rapid and simple means of isolating cholesterin. Thus, on dissolving the traces of unsaponifiable matter left by butter in a little hot alcohol, and allowing the liquid to cool, abundant crystals are deposited, which may be identified as cholesterin by their microscopic and chemical characters. A sample of butterine gave no cholesterin.

‡ I am investigating this interesting fact, and have obtained full confirmation of Chevreul's observation that sperm oil when saponified yields a peculiar solid alcohol instead of glycerin. It is distinct from cetyl alcohol, and distils, apparently without decomposition, at a very high temperature.

cess is capable. The process was in each case on about 5 grms. of the sample in the manner already described. The results are expressed in percentages.

Composition of Substance taken.				Unsaponifiable Matter found.
Fat Oil.		Hydrocarbon Oil.		
Olive.. ..	40	Shale oil ..	60	58·03
Olive.. ..	80	Shale oil ..	20	19·37
Olive.. ..	40	Rosin oil ..	60	59·42
Olive.. ..	80	Rosin oil ..	20	19·61
Rape.. ..	86	Shale oil ..	16	15·95
Cotton seed	60	Rosin oil ..	40	39·74
Linseed ..	60	Rosin oil ..	40	39·32
Castor ..	60	Rosin oil ..	40	38·88
Cod-liver ..	70	Rosin oil ..	30	30·80
Cotton seed	48	Coal-tar oil..	52	52·60
Lard.. ..	60	Paraffin wax	40	39·54
Lard.. ..	20	Paraffin wax	80	80·09
Olive.. ..	100	0		1·14*
Rape.. ..	100	0		1·00*
Castor ..	100	0		0·71
Cod-liver ..	100	0		1·82
Palm ..	100	0		0·54
Butter fat..	100	0		0·46
Sperm ..	100	0		41·49
Spermaceti	100	0		49·68
Japan wax	100	0		1·14
Lard	100	0		0·23*
Cacao butter	100	0		0·22

The following table indicates the general behaviour of the constituents of complex fats, oils, and waxes when the aqueous solution of the saponified substance is shaken with ether:—

Dissolved by the Ether.	Remaining in the Aqueous Liquid.
Hydrocarbon oils; including, Shale and petroleum oils.	*Fatty acids.* In combination with the alkalies used.
Rosin oil.	*Resin acids.*
Coal-tar oil.	
Paraffin wax and ozokerite.	*Carbolic* and
Vaseline.	†*Cresylic acids.*
Neutral resins.	
Unsaponified fat or oil.	*Glycerol* (Glycerin).
Unsaponifiable matter; as cholesterin.	
Spermyl alcohol; from sperm oil.	
Cetyl alcohol; from spermaceti.	
Myricyl alcohol; from bees'-wax.	

The hydrocarbon oil having been duly isolated by saponifying the sample and agitating the solution of the resultant soap with ether, its nature may be ascertained by observing its density, taste and smell, behaviour with acids, &c.

I have to express my indebtedness to Mr. Charles Harrison for the valuable assistance he has rendered me in establishing the analytical facts described in the foregoing paper.

Present Chemical Doctrines: General Theory of Chemical Action.—E. J. Maumené.—All chemical reactions may be regarded as actions either of contact or of mixture, and are regulated in the former case by specific gravity and molecular weight: in a word, by the molecular volume of the bodies present, and in the second case, by their molecular weight. He rejects the notions of molecule and atom, and employs the terms equivalent and atomic volume.—*Les Mondes.*

* The experiments marked with an asterisk were not made strictly by the same process as the majority.

† In a previous research I found that carbolic and cresylic acids were wholly removed from their ethereal solutions by agitation with caust soda.

ELECTRIC LIGHTING BY INCANDESCENCE.

At the recent meeting of the British Association Mr. J. W. Swan read a paper on the incandescent lamp invented by him. He said that the difficulty in producing electric light with carbon points was to make it steady and to moderate its excessive brilliance. By dint of improvements in the form and quality of the charcoal pencils and ingenious mechanism for maintaining the points of these pencils at one constant distance from each other, the first of these difficulties had to a very large extent been overcome. But the second had remained, and must remain as an insuperable obstacle to the application of this form of electric light to the general purposes of artificial illumination. That form of electric light was only exceptionally applicable, leaving the greater number and the more important of our wants in respect of artificial light unprovided for. It was, in his opinion, inapplicable to domestic lighting, and it was there that we experienced the most keenly the evils of the existing modes of artificial illumination by means of gas and oil lamps. In order to adapt electric light to house illumination it was necessary to entirely change the method of producing it. Electric light produced on the principle of incandescence had many good properties which the electric light known as the arc light had not. If the electric current which produced the incandescence was quite constant, the light emitted by the white-hot carbon was absolutely constant. There was not the slightest flicker or variation in it. It was, moreover, quite under control as to its brilliance, and might be made as yellow as gaslight or as white almost as sunlight. It communicated no noxious vapours to the air, and was not too costly. But the crowning merit of the electric light produced on the principle of incandescence was that it was indefinitely divisible without sacrifice of economy. A lamp might be so constructed as to give a light of 10 candles, or it might be constructed with larger carbon conductors so as to obtain a light of 100 candles from the incandescent carbon, and the smaller lamp would be almost as economical as the larger light for light. This property of divisibility into as small centres of illumination as might be required, which was inherent in this method of electric lighting to fully the same extent as in gaslight, combined with its steadiness, its good colour, and its wholesomeness, gave it a character of general applicability which was not possessed by any other kind of electric light. Nothing could well be simpler than the ideal incandescence lamp, A slip of carbon in a vacuum—that was all. To realise this idea much experimentation had to be gone through, and much disappointment to be suffered. In the vacuum lamps of earlier date it was neither possible to produce nor to maintain a perfect vacuum. There were always screws and washers about them, and these and the carbon itself in a cold state formed a reservoir of air quite sufficient to cause the disintegration and rupture of the carbon after a few hours' ignition. Four years ago he proceeded to experiment on this matter. His main idea was to employ in a good Sprengel pump vacuum a form of carbon made by carbonising paper at a high temperature, with which he had experimented many years before. The carrying out of his idea was made easy by the assistance he received from Mr. Stearn. Mr. Stearn undertook to mount some of his paper carbons in a good vacuum, and after many failures from carbons breaking, he at last succeeded in making some bulbs very highly exhausted, containing his paper carbons attached by electrically deposited copper to platinum strips, which carried the current in and out of the lamp. He showed a lamp lighted at a lecture he delivered before the Philosophical Society of Newcastle in February, 1879. The final results of the experiments were that when the vacuum was good the carbon did not appreciably wear away, and that when the contact between the ends of the carbon and the metallic conductors was good the globes did not blacken. Thenceforth it was possible to produce a durable electric

lamp that emitted a steady light of moderate power. Since then the manufacture of lamps on this principle, with slight modifications in the material out of which the carbon was made and the manner of making it, had been established on an extensive scale both in England and America, and in the electric exhibition now open in Paris electric light produced by incandescence occupied an important position. Already in this country the method has been put to actual use in house illumination and for lighting the saloons of passenger steamers. It had also been tried experimentally in coal-mines. Sir Wm. Thomson and Mr. Bottomley had made careful measurements of the energy expended in the production of light with his lamps, from which it appeared that with a small lamp, when rather less than one-sixth of a horse-power was expended on it, a light of 42 candles was emitted, or an aggregate of 270 candles per horse power. With a higher electromotive force, and therefore a larger current, 102-candle light was obtained from the same lamp. This amount of light was produced by the expenditure of rather more than one-fourth of a horse power—that is, one-horse power under the circumstances yielded 390 candles. By producing light in this manner, and employing the gas-engine as a motor to drive a dynamo-electric machine, the very interesting result was arrived at that more light was obtained from a given quantity of gas exploded in the gas-engine than could be obtained by burning the same quantity in the usual way to produce light directly. It was clear that the time was now ripe for the almost unlimited application of electric light to general purposes, and that engineers might with much advantage give their immediate attention to the many details which fell within their province in connection with the mechanical production and distribution of electricity on a large scale.

The subject of Electric Lighting by Incandescence was subsequently brought forward at the Mechanical Section, when Mr. Andrew Jamieson, Principal of the College of Science and Arts, Glasgow, read a paper on "Electric Lighting for Coal Mines." He said that in the discussion which followed the exhibition of Swan's lamp at the Society of Telegraphic Engineers in October last, Professor Tyndall remarked that probably this form of incandescent lamp could be adapted for use in coal mines as a safety lamp. Since then two practical trials had been made with that object in view—one at Pleaseby Colliery, near Nottingham, by Messrs. R. E. Crompton and Co., and the other at Earnock Colliery, near Glasgow (still working). Mr. Jamieson reviewed what had been done at these collieries, explaining the apparatus and appliances adopted at Earnock by means of a large wall diagram, made from scale drawings kindly lent to him by Mr. Gilchrist, the Manager. He showed working models of strong miners' lanterns encasing Swan's lamps and of air-tight contact makers of various designs and patterns, for preventing the inevitable spark which always takes place upon disconnecting leading wires or lamps from causing danger in a fiery mine. He showed by calculations and sketches on the blackboard that a plan of joining up a number of Swan's lamps in single parallel with a self-exciting Gramme, Siemens, or other form of dynamo machine, was neither the most economical nor handy for management, from the fact that the lamps required to be specially ordered and made of a slightly decreasing resistance in proportion to their distance along the main leads from the generator, and that without a costly and delicate current regulation there was considerable risk in spoiling the remaining lamps upon turning out a number of them. The plan of introducing an equivalent resistance to that of the lamps turned out was equivalent to throwing away so much energy or coal, because the resistance so introduced absorbed power equal in fact to that of the lamp or lamps which it replaced. He gave several plans for joining up the lamps which, in his opinion, were more economical and better, and he stated that by using Siemens's Dynamo Exciters, with their alternate current machines, the danger accruing from suddenly turning out a number of lamps was avoided, as the electromotive force remained practically constant (with low resistance leads and generator coil), and, therefore, the current passing the remaining lamp or lamps was always the same. For example, if 49 out of 50 lamps were suddenly switched out of circuit the remaining lamp would not be endangered, and would have the same current passing through it and give the same light as before. He described mechanical and electrical apparatus which he had designed for installing electric lighting in coal mines, and mentioned that he had found by experiment that good Swan's lamps would give forth light at the rate of 220 candle power per horse power absorbed by them. When incandescent at 20 candles.

Mr. Crompton, of the Pleasely Colliery, gave some details of this application of the light to their Colliery, and said, in contradiction of a remark by Mr. Jamieson, that the self-exciting Gramme machines could be made perfectly self-regulating. He was now carrying out the lighting of the Risca Colliery, thus going from one of the safest to one of the most dangerous pits in England, and they were applying there this experience they gained at Pleasely. The lighting of pits was a far more important matter than people thought; and with a view to settle the question of whether it was possible to explode the gases, he had asked Professor Abel to help him, and they were going to carry out some experiments. They hoped to be able to show that it was possible to make the lamps so that without any additional complication they could be used in mines in the midst of a dangerous mixture of gases.

Mr. J. W. Swan said the miners' lamp shown there that morning were intended to be used by attaching Brush wires to main wires in the colliery. The continual attachment of these wires was a drawback, as it limited the portability of the lamp, necessitating long lines of conducting wire of considerable thickness, which were expensive, and the retention of these conducting wires was attended with a possible source of danger. They were unable to eliminate completely danger arising from the breaking or contracting of the wires. He had therefore thought that a completely self-contained and portable miners' lamp would be an advantage, and he had in his hand a specimen of a lamp which possibly could be used in this manner. The lamp could be kept lit for six hours by a two-cell Faure secondary battery, and would give a light of 1 or 2 candle power during the time. The weight of the battery would not exceed 10 pounds, and to charge it afresh it would only be necessary to place it for a time in connection with the wires of a dynamo near the pit's mouth. The lamp and its attached battery need never come out of the pit.

Sir John Hawkshaw said he was in want of some means of lighting with electricity the Channel tunnel. The detached lamp mentioned by Mr. Swan seemed to remove one great difficulty in the way of using the electric light in mines or tunnels.

The Chairman (Dr. C. W. Siemens) said the application of the electric light to mines was a matter of great practical importance, and one involving many difficulties. He confessed that when the question was put to him by the Royal Commission whether he thought the electrical illumination of mines was a desirable object, and one that could be easily accomplished, he could not find a satisfactory answer. With regard to the second part of the question, many difficulties in the way had been manfully dealt with by the gentlemen who had addressed the section, and certainly there seemed to be a far greater promised success than he anticipated so soon. The backbone of the whole question was the incandescent lamp, through which we had the means of putting the source of the light away from all contact with the atmosphere of the mine. As Mr. Swan had shown, he could produce a lamp of two candle-power, such a power as a miner would require at the end of his working. The greatest difficulty which presented itself to every electrician was that of the con-

ductor. If the conductor should be broken or contact take place between two conductors, a flash of light would ensue, which might fire the mine. In dealing with this subject Mr. Jamieson and other gentlemen had devised several means of connecting and disconnecting the wires without risk of an electric spark, and that was the first condition to the successful application of electricity for lighting mines. Another condition was to insulate the conductors in such a way as to render an accidental contact between the two lines almost an impossibility; and he must say that he went much with Mr. Jamieson in contradistinction to the views expressed by Mr. Crompton, that low tension was a desideratum. By putting all the lamps in parallel circuits they avoided the necessity of high tension, and reduced the risk of accidental flashes of light through contact of the electric conductors. Mr. Swan had brought before them a system of lighting which commended itself very much to his mind, and that was to make an electric lamp which could be carried away from the conductor altogether. The Faure Battery gave them a means of storing electricity, and the miner might go to a central station and fill his electric lamp, not with electricity exactly, but with a chemical charge capable of producing electricity, the same as he went now to fill his lamp with oil, and with this store of energy he could probably go and work during the whole shift without being hampered by conducting wires, which no doubt were a matter of serious difficulty in coal mines. Taking it all in all, he thought means had been shown of avoiding the risks that would at first sight appear inevitable in attempting to light fiery mines by electricity, and he very much hoped to see the system largely introducing. He thought the object Sir John Hawkshaw mentioned could be accomplished without difficulty.

ON THE MOLECULAR WEIGHT OF HYDROFLUORIC ACID.*

By Prof. J. W. MALLET, F.R.S.

THE analogies of fluorine with the halogens on the one hand and with oxygen on the other have often been remarked upon. The general resemblance of fluorine compounds to the corresponding compounds of chlorine is manifest, and the two elements are usually classed together; but some striking differences force themselves upon the attention, such as those existing between the chloride and fluoride of calcium, chloride and fluoride of silver, &c., and the marked tendency of the fluorides to the formation of double salts with formulæ analogous to those of oxygen compounds, as well as the formation of many salts including both oxygen and fluorine, suggests some close natural relation between these elements themselves.

When the principle of quantivalence or atomicity first began to assume distinct shape, it became a matter of special interest to decide whether fluorine should be classed with chlorine amongst the monad elements, with the formula HF for hydrofluoric acid, and the atomic weight 19 for fluorine itself, or should be placed with oxygen amongst the dyads, writing H_2F for hydrofluoric acid, and assuming the atomic weight of fluorine as 38. For some time, although analogies were chiefly in favour of the former view, no direct evidence was available for the settlement of this question, but in 1869 it seemed to be supplied by the researches of Gore,† who, heating silver fluoride in contact with an equivalent quantity of pure and dry hydrogen, observed that "one volume of hydrogen in uniting with fluorine produces, not simply one volume of gaseous product, as it does when uniting with oxygen, but two volumes, as in the case of its union with chlorine." Further on, in the same paper, after giving his results as to the amount of silver in the fluoride used, he says: "These results, combined with the foregoing experiments on molecular volume, agree with the conclusion that a volume of hydrogen weighing 1 unites with 19 parts by weight of fluorine to form 2 volumes of hydrofluoric acid, and that the specific gravity of gaseous anhydrous hydrofluoric acid is ten times the amount of that of hydrogen."

Gore's experiments were made with somewhat small quantities of the materials used (about a gramme of silver fluoride and 90 or 100 c.c. of hydrogen), and in opaque vessels of platinum, the volume assumed by the gaseous hydrofluoric acid being ingeniously determined by raising or lowering the cylindrical platinum receiver, so that the level of the mercury in which it was placed remained the same inside and out, and reading off an external scale. The whole apparatus was heated in an air-bath to 93° to 100° C. before making the final reading. It is stated that fourteen separate attempts were made to ascertain the volume of gaseous product formed, but the numerical results of only two of these are given. They seem fairly to establish the fact that at temperatures near 100° hydrofluoric acid exists as HF, 93·3 and 98·5 per cent respectively of the theoretical volume being obtained after allowance for expansion at the temperature employed. The atomic weight of fluorine is thus established as 19, not 38.

Certain measurements of the gaseous acid are, however, given for lower temperatures, though far above the boiling-point (67° F., as found by Gore himself = 19·5° C.), which represent distinctly smaller volumes. Thus at 139° F. (59·5° C.) the volume was but 85·8 per cent of that required by theory, and at 160° F. (71° C.) it was 88·1 per cent.

Hence it seemed still desirable to try to ascertain whether the acid exhibits a different but definite vapour density at a temperature nearer the boiling-point, though high enough to preclude any actual liquid acid remaining, with even rough weighings, and if possible in transparent or translucent vessels. With this object in view I have made the following experiments.

Perfectly pure Greenland cryolite, carefully selected in choice fragments, was pulverised in a clean iron mortar, heated to 300° C. for some time, and transferred while still warm to a well dried and warm bottle. Sulphuric acid was prepared of full strength by adding to a quantity of the purified acid of 95 or 96 per cent a small excess of pure sulphur trioxide, and passing for several hours a well dried and gently warmed current of air through the liquid; this was also preserved in a well stoppered bottle until needed. The cryolite and acid were heated together in a leaden retort, the capital of which was clamped on without lute, and the hydrofluoric acid vapour given off was conducted downwards through a worm of leaden tube, 6 m.m. in interior diameter and 3·5 metres long, surrounded by crushed ice, into a leaden bottle cooled by a freezing mixture of ice and salt. The interior of all the leaden apparatus had been previously crusted over by passing hydrofluoric acid vapour through for some time. The joints were made by simply wrapping tightly with lead foil, and ligating with wire. The quantity of the materials used was such as to produce eight times the amount of hydrofluoric acid necessary to fill with vapour the leaden bottle and the flask and connecting tubes to be afterwards used, even assuming the highest vapour density that could well be expected.

The flask in which the vapour was to be weighed was of good Bohemian glass, and held nearly 4½ litres, being as large as could be well managed in the balance case. It was slung in a light network of platinum wire, with a suspending ring at top, and was, after thorough drying, carefully coated over the whole inside surface with clear,

* The substance of this paper was verbally presented, by invitation, at a meeting of the National Academy of Sciences at Washington, April 22, 1881.

† *Philosophical Transactions* for 1869. A further paper, on silver fluoride, appeared in 1870.

colourless paraffin,* poured in in the melted state, and evenly distributed by turning round and round the gently-warmed flask. The melting-point of the paraffin was 56° C., well above the temperature to be afterwards applied. The neck of the flask was accurately fitted with a sound, soft cork, previously well dried and soaked in paraffin. Through this cork passed two glass tubes of about 5 m.m. bore, one of which extended about two-thirds of the way to the bottom of the flask, and just above the cork was bent at right angles, the short projecting limb being some 20 m.m. long. The other tube ended just below the cork on the inside of the flask, came out straight, and projected also about 20 m.m. on the outside. Both were drawn down a little in diameter, about 5 m.m. from the outside ends, so as to form a little socket for the small cork by which each tube was to be closed, insuring this cork coming to exactly the same position when inserted. The two small corks, the whole of the interior of the glass tubes, and so much of their exterior surface as was to be inside the flask were thoroughly protected by paraffin. The specific gravities of the glass, paraffin, platinum, and paraffin-coated corks with tubes were taken at about the temperature to be used, and the figures obtained corrected for buoyancy in air by the formula—

$$G_r = G_a - \rho(G_a - 1).\dagger$$

From the thus corrected specific gravities, and careful weighings in air of observed temperature and pressure, the volumes and absolute weights *in vacuo* of all the materials concerned were deduced, save in the case of the hydrofluoric acid vapour itself, the volume of which was obtained by an actual calibration‡ of the part of the flask and tubes occupied by it.

As soon as the distillation of the acid and its collection in the leaden bottle was complete, the retort and capital were disconnected from the worm, and the upper end of the latter connected with the bent tube of the paraffin-lined flask, interposing in the first experiment another small flask, also protected by paraffin, and containing a little phosphorus pentoxide, as the means of removing any last traces of aqueous vapour. Removing the freezing mixture from about the leaden bottle, the latter was surrounded with water at 25° C.; and the water surrounding the worm was brought to the same temperature, while the flask was at 1° or 2° lower. The hydrofluoric acid thus vapourised filled the whole apparatus, gradually expelling the air, and the excess escaped through a long india-rubber tube attached to the exit glass tube, and carried through a hole in the door-casing to the outside atmosphere, thus avoiding danger to the lungs and eyes, and risk of corrosion of the outside of the flask. When the escape of vapour slackened, the two tubes entering the flask were quickly disconnected from the rest of the apparatus and the little paraffin-soaked corks at once inserted. In doing this but one tube at a time was open, and that but for a moment.

The flask was then placed in a deep cylinder of sheet zinc, of diameter to just fit it, and this was immersed in a much larger cylinder, containing some 30 litres of water, at a little over 30° C., a cover with small openings in it being fitted over both. Previous experiment with a similar flask of air and enclosed thermometer showed what small allowance to make in the temperature of the water in order to bring the flask and its gaseous contents to the desired point. In the actual experiments with hydrofluoric acid a thermometer was placed on the upper part of the outside of the flask, while another was immersed in the water of the outer vessel. From time to time, as the temperature of the flask rose, the little cork was partly withdrawn for a moment from the straight vertical exit tube, and the surplus vapour was thus allowed to escape. In doing this one or two small, but bad, burns were made upon the fingers by the frightfully corrosive dry acid, of whose dangerous character one can hardly speak too strongly.

When the temperature of the flask had become stationary at or very close to 30° the little corks were firmly inserted in their seats, the flask was removed from the zinc cylinder, allowed to cool to the temperature of the balance-room, which had, however, been warmed up for several hours by a stove to a little over 25°, and was then accurately weighed.

The following result was obtained in the first experiment:—

Weight of flask, &c., and vapour, *in vacuo*,	393·781 grms.
" " " empty, "	386·531 "
Weight, *in vacuo*, of 4347·4 c.c. of vapour at 29° C. and 743·7 m.m. (cor.) = 3846 c.c. at 0° C. and 760° m.m.	7·250 grms.
Hence, 1 litre of vapour at 0° and 760 m.m. .. .. =	1·885 grms.
Hence, specific gravity of vapour (H* = 1) =	21·06 grms.
Or molecular weight .. .. =	42·12 grms.

As soon as the weighing was over the flask was washed out with distilled water enough to largely dilute the acid, into a platinum dish, and the purity of the liquid examined. It was quite clear and free from silicon or lead, and gave no reaction for sulphuric or sulphurous acid, but on testing with ammonium molybdate very distinct evidence was obtained of the presence of phosphoric acid. This had been suspected from the energy with which the phosphorus pentoxide, of which fortunately but little had been used, was attacked by the vapour. In all probability phosphorus penta-fluoride had been formed and carried forward with the hydrofluoric acid. This may serve to account for the vapour density of the latter coming out somewhat too high for even the formula H_2F_2 (requiring sp. gr. = 20). Any traces of air or aqueous vapour which might have been present would, of course, have tended, on the contrary, to produce a lower result.

In order to avoid this ascertained source of error in a second experiment, the phosphorus pentoxide was omitted altogether, the upper end of the leaden worm was directly connected to the large flask, and as the means of finally drying the vapour, a little sulphuric acid of full strength (pure H_2SO_4—not SO_3) was added to the liquid hydrofluoric acid in a leaden bottle while it was still in the freezing mixture, before proceeding to vapourise the latter acid at the very moderate temperature of 25°. A new flask, lined with paraffin and fitted with tubes as before was used, and the following result was obtained:—

Weight of flask, &c., and vapour *in vacuo*	428·255 grms.
" " " empty "	421·436 "
Weight, *in vacuo*, of 4394·7 c.c. of vapour at 30·5° C. and 745·2 m.m. (cor.) = 3876·5 c.c. at 0° C. and 760 m.m.	6·819 grms.
Hence 1 litre of vapour at 0° and 760 m.m. .. .. =	1·759 grms.
Hence specific gravity of vapour (H = 1) =	19·66 grms.
Or molecular weight.. .. .. =	39·32 grms.

In this case the dilute acid washed out from the flask after the experiment seemed to be quite pure, or at any rate was free from silicon, lead, sulphuric, and sulphurous acids. In both experiments the flask was, immediately after weighing, carefully inspected in a strong light, and no visible trace of liquid could be observed on the inside surface.

* The dry acid in the gaseous state does not act upon glass, but, as it did not seem certain that, by the process used, perfect exclusion of moisture would be secured, it was thought better to take this precaution.

† G_r being the real specific gravity of the body, G_a the apparent specific gravity of same taken without air correction by simple weighings in air and water, and ρ the ratio of the densities of air and water under existing conditions of temperature and pressure.

‡ With water of known temperature, as the weight of mercury necessary would hardly have been safely borne by the flask.

* One litre of hydrogen at 0° and 760 m.m. at Univ. of Va. = 0·089488 grm.

The glass, examined after removal of the paraffine, was found quite uninjured, except a slight trace of corrosion on the outside close to the exit.

The figures obtained obviously justify the assumption that at 30° C. the molecule of hydrofluoric acid vapour should be represented not as HF, but as H_2F_2, since the agreement with this assumption of the vapour density obtained in the two experiments is too close to be fairly accounted for by the mere general idea of imperfect gaseous condition, and it is certain that no such quantity of actually liquid acid as would be necessary to account for the double weight could possibly have escaped detection on the inner surface of the flask. At higher temperatures, such as those at which Gore's measurements were made, dissociation manifestly takes place, leading to the production of di-atomic molecules of HF.

The structure of the molecule of double weight, H_2F_2, may be well viewed as resulting from fluorine behaving not only as a monad but also as a triad, and acting in double atoms,

$$-F=F-,$$

like those of nitrogen,

$$-N=N-$$

in the di-azo compounds. In such a condition the element presents a pseudo-dyad character, and becomes capable of replacing oxygen, and manifesting the *linking* function of the latter. Admitting, therefore, that the atomic weight of fluorine remains fixed at 19, we can see that the molecule of hydrofluoric acid may at high temperatures be H—F, analogous to that of hydrochloric acid, while at a little above the boiling-point under ordinary pressure the structure may be H—F=F—H, and thus analogous to that of water.*

This assumption, supported by the experimental evidence now brought forward, serves conveniently to explain the constitution of a number of fluorine compounds, whose formulæ are difficult to write in a satisfactory way if fluorine be considered as exclusively monad.

Thus we may view:

Potassium hydro-fluoride—KHF_2 as

Potassium boro-fluoride—KBF_4 as

Potassium silico-fluoride—K_2SiF_6 as

Potassium fluo-tantalate—K_2TaF_7 as

Potassium fluoxy-niobate—K_2NbF_5O as

Potassium fluoxy-niobate (cuboid-Marignac)—K_3NbF_6O as

* Gore sums up the results of his numerous experiments on the chemical behaviour of this interesting substance with the sentence: "From the various experiments already described, we may conlude that hydrofluoric acid is by its properties placed between hydrochloric acid and water, but is much more closely allied to the former than to the latter."

† On the type of a meta-silicate. Like formulæ apply to the analogous compounds of titanium, zirconium, and tin.

‡ Or these formulæ may be doubled, so as to correspond exactly with the oxygen pyro-tantalate and pyro-niobate.

§ On the type of an ortho-niobate.

Potassium fluoxy-tungstate—$K_2WF_4O_2$ as

Cryolite—NA_3AlF_6 as

Chiolite—$Na_3Al_2F_9$ as

Chodneffite—Na_2AlF_5 as

Topaz—$Al_2SiF_2O_4$ as

Apatite—$Ca_5P_3FO_{12}$—might be written:

but, in view of the replacement of fluorine by chlorine in this mineral, as in the analogous pyromorphite and mimetite, it is doubtless better, as well as simpler, to suppose the molecule to be merely—

—*American Chemical Journal.*

Researches on the Anhydrous Gallium Chlorides.—Lecoq de Boisbaudran.—Gallium perchloride corresponds to the oxide Ga_2O_3, existing in the ammonium-alum of gallium. Gallium perchloride melts about 75·5°, and boils about 215° to 220°. Its vapour-density, taken at about 60° above its boiling-point, is = 11·9, theory indicating 12·2 for Ga_2Cl_6 = 2 vols. At higher temperatures the effects of dissociation are observed and increase rapidly. Gallium perchloride liquefied by heat has at 80° a density = 2 36 as compared with that of water. The author has latterly been unable to obtain the hydrated perchloride in the state of crystals.—*Comptes Rendus.*

* As for the normal tungstate. The case of the fluoxy-molybdate is of course the same

† Like andalusite—Al_2SiO_5—

ON A CURIOUS ACTINIC PHENOMENON.

By J. CAWLEY.

I NOTE, with some surprise, that Dr. Phipson, in his second note on the above-named subject, takes not the slightest notice of my criticism of his analytical and other results. I pointed out that his analysis was obviously erroneous, and that his other results differed widely from those obtained by myself, and he replies that I "do not appear to have the least idea of the cause of the phenomenon under consideration."

It appears to me that such an answer is somewhat inconsequent, and his inference from my remarks not all justified. But Dr. Phipson seems to have a peculiar talent for making large inductions from scanty and inadequate data. For example, he assumes that a new element Actinium (would not Phipsonium be a more suitable name if the new body should be isolated ?) may exist in the pigment examined by him, and cause the discolouration in question. The new body he supposes may also give rise to the colour which blende generally possesses. Most chemists would, I opine, consider the presence of iron, manganese, &c., in the mineral as sufficiently explanatory of the colour. Should Dr. Phipson fail to ascertain the origin of the photogenic character of zinc-sulphide pigments, it will surely not be owing to a lack of hypothesis. He has successively assumed that the discolouration was caused by a double sulphate of iron and barium, by the new body Actinium, by an equally hypothetical sub-oxide of zinc, and an alternate reducing and oxidising process. But unfortunately none of the theories are entirely satisfactory. I notice too that in his second note he speaks of the zinc pigments examined by him, as containing "minute" quantities of iron, &c., while in his first note he finds 2 per cent of FeO in a typical pigment of the same class. Does he call 2 per cent a "minute" quantity? I am afraid such a "minute" quantity would hopelessly ruin any zinc-sulphide pigment by causing it to be more nearly black than white.

I hope shortly to be able to send a brief account of my own results in connection with the matter under consideration. I have repeated the experiments a large number of times, and I am, in consequence, confident in the general accuracy of my results.

But as I do not possess Dr. Phipson's talent for inventing hypotheses, I have not yet devised a theory that will agree well with all the facts of the case. But some fellow-reader may be more successful.

Newark, N. J., U.S.A.

PROCEEDINGS OF SOCIETIES

AMERICAN CHEMICAL SOCIETY.*

September 2, 1881.

Dr. ALBERT R. LEEDS, Vice-President, in the Chair.

THE minutes of the previous meeting were read and approved.

As there was no meeting of the Board of Directors, the Committee on Papers and Publications was next called upon to report. Dr. ENDEMANN, speaking in reference to the *Journal*, said that all the matter is now in type, and that he expects the *Proceedings* will be out in a few days.

The LIBRARIAN then reported that the collection of books presented to the Society by Dr. Lindsley is composed of—Pharmaceutical works, 7; 10 volumes; physics and chemistry, 13 works; 30 volumes. Special subjects (Physics and chemistry), 6 works and 6 volumes; metallurgy and mineralogy, 26 works, 29 vols. Total, 52 works and 75 volumes.

No members to be elected.

The following gentlemen were then nominated:—As Member—Albert L. Colby, Ph.B.; proposed by Arthur H. Elliott, Elwyn Waller, A. R. Leeds. As Member—Dr. Lawver; proposed by Benj. S. Thedrik, P. Casamajor, H. Endemann. As Member—Dr. Harry von Bauer; H. Endemann, James H. Stebbins, jun., P. Casamajor. As Member—Dr. P. Radenhausen; proposed by H. Endemann, James H. Stebbins, jun., P. Casamajor. As Member—Dr. Louis Habel; proposed by H. Endemann, J. F. Battershall, M. Benjamin. As Member—H. C. Heipe; proposed by H. Endemann, James H. Stebbins, jun., J. F. Battershall. As Member—Wm. L. Leman; proposed by Q. J. Parker, P. Casamajor, E. Waller. The resignation of Mr. W. P. Mason was then read and accepted.

The first paper of the evening, "*On the Detection of Oleomargarine*, by P. CASAMAJOR, was then read. The detection of this substance is based upon the specific gravity of fats in methyl alcohol of about 54 per cent, butter floating in it, while the oleomargarine sinks to the bottom.

The second paper read was "*On Starch-Sugar Syrup mixed with Sugar-House Syrup*," by P. CASAMAJOR, was then read. This test depends upon the solubility of sugar-house syrup in methyl alcohol, whereas the starch-sugar syrup is thrown down as a white precipitate. For 10 vols. of syrup it requires about eight times as much alcohol to complete the separation.

The third paper, "*On a Short Table for Testing Sugar by Inversion*," by P. CASAMAJOR, then followed.

The fourth paper of the evening, "*On a New Form of Apparatus for Gas Analyses*," by ARTHUR H. ELLIOTT, was then read. With this apparatus the large amount of washing (as with the Wilkinson apparatus) is obviated, which Mr. Elliott found to reduce the illuminants as much as 2 per cent.

Some remarks by Dr. Endemann, Mr. Elliott, and Mr. Stebbins then followed, after which the meeting adjourned.

* Communicated by James H. Stebbins, jun., Recording Secretary.

NOTICES OF BOOKS.

Annals of Chemical Medicine including the Application of Chemistry to Physiology, Pathology, Therapeutics, Pharmacy, Toxicology, and Hygiene. Vol. II. Edited by J. L. W. THUDICHUM, M.D. London: Longmans, Green, and Co.

THERE is very little matter in this work which might not be legitimately and profitably discussed in our pages. Of capital importance is the first memoir, "Researches on the Chemical Composition of the Non-phosphorised Group of Nitrogenised Principles of the Brain." Among the substances isolated may be mentioned cerebrose, $C_6H_{12}O_6$, a new crystalline sugar; sphingosine, a new alkaloid; psychosine, also a nitrogenous compound; aesthesine, probably a compound of sphingosine and neuro-stearic acid. The author considers that phrenosine is made up of 1 mol. each of sphingosine, 1 of neuro-stearic acid, and 1 of cerebrose, minus 2 mols. water. Psychosine is the cerebroside of sphingosine; it is an alkaloid, but of a less pronounced character than sphingosine. Aesthesine is a compound of sphingosine with neuro-stearic acid minus water. Cerebrenic acid has not yet been obtained in a state of purity, but from preliminary analyses Dr. Thudichum considers it as consisting of the same radicles as phrenosine, *i.e.*, cerebrose, sphingosine, and neuro-stearic acid, though in different proportions.

In a paper on "Hemisymmetry in the Chemical Constitution of Gelatin, Semiglutin, and Hemicolline, and the Relation of Collogen to Gelatin," the existence of chondrinogen and chondrine is questioned. It is suggested that

chondrine may be a mixture of gelatin and mucine held in solution by salts.

The memoir on the "Colouring Matter of the Rods and the Cells of the Choroid Coat of the Retina" contains some appropriate remarks on a substance doubtless well known to our readers as visual purple. "Hardly had the presence of a coloured ingredient of the retina sensitive to light been perceived, when we heard at once of a 'photo-chemistry' of the retina, there being in the whole of the observations not a chemical fact, except, perhaps, that the red matter bleaches in light and now and then becomes red again in the dark, and that the red matter is soluble in biliary salts. The enthusiasm extended alike to the terminology, so that a matter of which its discoverer said that 'it is red and not purple' was, in spite of him, named purple, and, thus robed, the sensation was held up to the profession and the public as the discovery of 'seeing matter' or 'visual substance.' The existence of such a visual substance seemed to be pre-determined in the inner consciousness of some physiologists who believe that 'a knowledge of the changes of the visual substances would at once enable us to bridge over the assumed gap between the waves of the luminous ether and the waves of the visual nervous impulses.' But we perceive that there are already so many gaps in the structure of the retina which the luminous and nervous impulses, nevertheless, get over without particular bridges that the gap alluded to does not add much to their difficulties or to the problems to be solved by physiologists. The particular delusion of 'photo chemistry' by means of a 'visual substance' is born out of a particular bias of this photographing age. . . . The discovery of the visual matter had not even the traditional four years' run of most modern physiological discoveries, but perished, mainly by the hands of its author, after a short lived notoriety, and it is now admitted that the presence of this red matter is not essential to even the most accurate vision."

There is something in this quotation which strongly reminds us of the manner in which Prof. Kolbe disposes of speculations whose authors have allowed too loose rein to the imagination.

We much regret that want of space does not allow us to extend any further our notice of this interesting volume.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 5, August 1, 1881.

Modification of the Electric Lamp.—M. Jamin.—Inserted at length.

Researches on Perchloric Acid.—M. Berthelot.—A thermo-chemical study. The facts observed explain the differences of stability and activity between pure perchloric acid and the same acid combined with different proportions of water. The author has succeeded in obtaining the mono-hydrated acid in a crystalline form. The heat of solution of the liquid mono-hydrate in 100 parts of water at 19°= +20·3 cals., or more than double that of ordinary mono-hydrated sulphuric acid. This enormous heat of hydration explains the extreme difference between the reactions of this acid diluted with water, when it is almost as stable as dilute sulphuric acid, and the reactions of the mono-hydrated acid which acts with explosive violence upon oxidisable bodies. In dilute solution it is not decomposed by sulphurous, hydrosulphurous, hydriodic acids, sulphuretted hydrogen, free hydrogen, zinc in presence of acids, sodium amalgam in presence of water, either pure, alkaline, or acidulated, or by electrolysis.

Application of Electro-motors and of the Secondary Batteries of M. G. Planté to the Direction of Aërostates.—G. Tissandier.—Not suitable for abstraction.

Wave-lengths of the Spectral Bands given by the Compounds of Carbon.—M. Thollon.—The results are given in a table.

Spectra of the Comets Cruls and Schæberle.—P. Tacchini.—Useless without the diagrams.

Theory of Dissociation: Influence of Pressure.—G. Lemoine.—The author examines mathematically the speed of combination according to the probability of the meeting of the molecules, the dissociation of homogeneous systems, and the influence of pressure upon dissociation, both according to theory and experiment.

Formation-heat of Explosives: Numerical Data.—MM. Sarrau and Vieille.—The determinations given refer to nitro-glycerin, nitro-mannite, gun-cotton, and potassium and ammonium picrates.

Lead, Cadmium, and Mercury Oxycyanides.—M. Joannis.—The author describes the preparation and properties of these compounds.

Combustion-heats of Heptan and Hexa-hydro-toluen.—W. Louguinine.—A thermo-chemical study. The combustion-heat of heptan is at most from 6000 to 8000 cals., and that of hexa-hydro-toluen is 149,000 cals.

The Magnesia Industry.—T. Schlœsing.—The author proposes to obtain magnesia from sea-water by means of lime. After precipitation and settling for a day 1 cubic metre of sea-water yields a gelatinous precipitate of magnesia occupying the bulk of 80 litres. He mixes with his magnesian mud a calculated quantity of phosphoric acid in dilute solution, and thus obtains a precipitate of tribasic magnesian phosphate, which condenses on settling, is capable of filtration through cloth or on the filter-press, and in a few minutes combines with ammonia to form an ammonium-magnesium phosphate.

Colorimetric Determination of Salicylic Acid in Alimentary Substances.—H. Pellet and J. de Grobert.—The authors prepare a series of eight test-tubes, of from 0·20 to 0·22 metre in height, and of 0·015 to 0·018 metre in diameter, into which are put respectively 1 c.c., 0·75 c.c., 0·50 c.c., 0·30 c.c., 0·20 c.c., 0·1 c.c., 0·05 c.c. of a solution of salicylic acid containing 1 grm. per litre. The volume is in each case made up to 10 c.c. with distilled water. Three drops of ferric chloride of from 1·005 to 1·010 sp. gr. are then added to the first tube, two to the second and the third, and one drop to the others, except the last, where it is sufficient to touch the inside of the test-tube with the point of the pipette containing the ferric chloride. An excess of the salt of iron considerably modifies the tint produced. They take then, *e.g.*, 100 c.c. of wine, to which are added 100 c.c. of ether and 5 drops of sulphuric acid at 30° B., to displace the salicylic acid from its combinations. Agitate, let settle, draw off the supernatant ether by means of a pipette. This operation is twice repeated, and the decanted ether is rapidly distilled in the water-bath. The residue is transferred into a porcelain capsule of 0·06 metre in diameter. The retort is washed with a few c.c. of ether, and the whole placed for a few moments on a stove at 35° to 50° to expel the bulk of the ether. Add at most 1·5 c.c. of a solution of caustic soda, of which 10 c.c. = 0·4 grm. NaO. This quantity is capable of saturating 0·2 grm. salicylic acid. It is then evaporated to dryness in the water-bath, when the salicylic acid remains as sodium salicylate. The residue of this second evaporation to dryness is mixed with 5 drops sulphuric acid at 30° B., and 20 c.c. benzol are then added. The whole is poured into a test-tube, shaken, and filtered. Take 10 c.c. of the filtrate and place them in a test-tube of the same size as those containing the colour standards. Add 10 c.c. of distilled water, and one or two drops of dilute ferric chloride, and shake several times. If sali-

cylic acid is present it passes into the lower part of the liquid and occasions a violet colour. The shade obtained is then compared with those of the colour-standards.

Saccharine Matter of Soja Hispida.—A. Levallois.—This sugar approaches in some of its properties to cane sugar, but it agrees with mellitose in producing mucic acid on treatment with nitric acid.

Applications of Electric Motors.—G. Trouvé.—A motor on the author's principle worked by six Planté's secondary elements was placed on a tricycle, the weight of which, including the rider and the batteries, was 160 kilos. The speed produced was 12 kilometres per hour. On June 26 a boat was propelled with this motor on the Upper Lake in the Bois de Boulogne. The speed reached was 3 metres per second, which, after five hours' working, declined to 2·30 metres per second.

No. 7, August 16, 1881.

The Alcamines.—A. Ladenburg.—This name is given by the author to an entire class of bases, which, like atropine, possess the property of becoming etherified in a hydrochloric solution, yielding, like tropine, ethers, which are always bases, and which approach the natural alkaloids, both in their properties and their composition. These new bases fulfil a double function, that of an alcohol and an amine. They are formed by the action of the chlor-hydrides on the secondary amines. The author has prepared and examined piper-ethyl-alcamine, tri-ethyl-alcamine, di-allyl-ethyl-alcamine, di-piper-allyl-alcamine, and piper-propyl-alcamine.

Solubility of Magnesium Carbonate in Water charged with Carbonic Acid.—P. Engel and J. Ville.—The authors give their results in the form of tables.

The Cobaltamines.—M. Porumbaru.—An account of the acid and neutral pyro-phosphates of the roseo-cobaltamines.

Bulletin de la Société Chimique de Paris.
No. 9, May 5, 1881.

A New Eudiometer.—J. Riban.—The apparatus cannot be usefully described without the four accompanying figures.

Attack of Platinum on Exposure to Flame.—A. Rémont.—The carbonaceous deposit formed on platinum after exposure for some time to an oxidation flame, contains an amount of platinum so small that it is generally neglected, when wiping the base of a crucible blackened in the flame before weighing. On calcining 0·022 grm. of a carbonaceous deposit formed on a platinum capsule on exposure for half an hour to a red heat in the upper part of a Bunsen flame, the author obtained 0·01 grm. of the metal. Further experiments showed that the corrosion of the platinum is due not to carbon in suspension, but to one or more of the gaseous elements of the flame.

Spontaneous Oxidation of Mercury and other Metals.—M. Berthelot.—The author finds that perfectly pure, dry mercury, exposed to the air at 10° in a place free from the fumes of the laboratory, and covered with paper to keep off dust, becomes slowly covered with a pellicle of mercurous oxide, which is reproduced if removed. Hence mercury, like iron, zinc, cadmium, lead, copper, and tin, undergoes a superficial oxidation on exposure to the air.

Purification of Carbon Disulphide.—E. Allary.—The author covers the sulphide with a layer of water, to which a solution of permanganate is added frequently in small quantities. Each addition is followed by stirring and is repeated till the supernatant liquid retains its purple colour. The permanganate is then removed by washing and decantation, and freed from water by means of a tap-funnel, and filtered through a dry double filter of Prat-Dumas paper. The purified sulphide must not be exposed to light.

A Solution of Cadmium Tungsto-borate.—D. Klein.—This solution, sp. gr. 3·28, is proposed for effecting the proximate analysis of rocks, as the lighter minerals float and the heavier constituents only sink.

Sodium Tungsto-borate.—D. Klein.—In this paper the author describes the formation of the tungsto-borates.

Action of Phosphorus Perchloride upon Isobutylic Aldehyd.—S. Œconomides.—The principal product of the reaction is isobutylene chloride.

Preparation of Isobutylic Acetal.—S. Œconomides.—This compound is obtained by passing a current of hydrochloric acid gas to saturation into a well-cooled mixture containing equal weights of isobutylic aldehyd and of absolute alcohol. The upper of the two layers formed is a mixture of chlor-ethyline and of isobutylic acetal. This product is mixed with sodium ethylate, and heated for several hours to 100°. Isobutylic acetal is then separated by means of water.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

Normal School of Science.—Dr. Frankland, F.R.S., is Professor of Chemistry at this Science School, and Dr. Roscoe and Dr. Russell are the Examiners.

Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane.—The 59th Session of this Institution will commence on Monday next. Evening Classes, which are open to both sexes, are held for the study of Ancient and Modern Languages, Mathematics, Natural, Applied, and Mental Science, Literature, History, Law, Art, Music, &c.; in fact every opportunity is offered at this Institution for students to prepare for any occupation or profession. The fees are very moderate, and the classes meet at hours which are convenient to persons occupied during the day. The 58th Anniversary will be held in December, under the the Presidency of the Earl of Lytton, and the Countess of Lytton has kindly consented to distribute the prizes to the successful candidates of the past session. The committee again appeal for contributions towards the New Building, and, inasmuch as the present Institution is utterly inadequate for the work carried on, it is hoped that the £4000 asked for prior to the laying of the Foundation Stone will be subscribed by those friends of popular education who are anxious to perpetuate and extend the work carried on by this the parent and largest Evening Educational Institution.

Mason Science College, Birmingham.—The Session will commence on Monday, October 3rd.—*Chemistry and Metallurgy.*—Prof. W. A. Tilden, F.R.S., assisted by Mr. W. W. J. Nicol, M.A., and Mr. G. H. Morris, F.C.S. The instruction embraces twenty elementary lectures, about sixty lectures on Inorganic Chemistry, about forty lectures on Organic Chemistry, and a course of about twenty lectures on Metallurgy, with laboratory practice and instruction in both Chemistry and Metallurgy. Excursions are also arranged to some of the great factories in and near Birmingham in which Chemical and Metallurgical industries are carried on. *Physics.*—Prof. J. H. Poynting, M.A., assisted by Mr. J. H. Riley. The complete course in Physics extends over three years, and consists of lectures and laboratory instruction and practice. In the lecture classes examples will be set to be worked out of class. Further particulars as to fees, &c., can be obtained in the College "Calendar," published by Cornish Bros., New Street, Birmingham.

College of Science and Arts, Glasgow.—Lecturer on Chemistry, Mr. R. R. Tatlock, F.R.S.E., F.C.S., &c., assisted by Mr. J. Clark, Ph.D., F.C.S. The course will

consist of twenty-eight lectures, extending over seven months, commencing with an introductory lecture (free) on Friday evening, October 7th. Fee, for private students, 5s.; for students going in for Science and Art Examinations in May, 5s. Practical Classes: Elementary, Thursday; Advanced, Tuesday—Fee, £3 3s. Lectures on Magnetism and Electricity by the Principal, Mr. Andrew Jamieson, C.E., on Tuesday evenings. Fees as for chemical lectures.

COLLEGE OF AGRICULTURE, DOWNTON, SALISBURY.—Chemical Department.—*Professor*, J. M. H. Munro, D.Sc. Lond., F.C.S. Courses of lectures are given on Inorganic and Organic Chemistry, with special reference to their bearing on Agricultural Chemistry. The chemistry of the soil and the atmosphere, of plant and animal life, of manures, feeding-stuffs, farm and dairy products, are fully dealt with. The laboratory course consists of three sections, dealing respectively with chemical manipulation, qualitative analysis, and quantitative analysis, and is based on the system laid down by Professor A. H. Church, M.A., F.C S., F.I.C., in his "Laboratory Guide."

WESLEY COLLEGE, SHEFFIELD.—Mr. A. H. Allen, F.C.S., gives lectures and lessons in Chemistry. The Rev. W. H. Dallinger, F.R.S., gives lectures and demonstrations in Biology, Palæontology, and Geology.

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TENDERS FOR SULPHURIC ACID.

The Directors of the Bath Gas Light and Coke Company are prepared to receive Tenders for the supply and delivery at their Works by Midland Railway of about 300 Tons of Sulphuric Acid in the year from 1st of November next; delivery to be made in such quantities and at such times as may be directed.

Particulars, with form of Tender, may be had upon application.

Tenders, endorsed "Tender for Acid," to be sent in on or before the 18th of October next.

The Directors do not bind themselves to accept the lowest or any Tender.—By order,

GEORGE HELPS, Secretary.

Gas Works, Bath, Sept. 23, 1881.

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The Day Courses will commence on October 7th. The Evening Courses on Chemistry and Physics, Mineralogy and Geology, on the 3rd, 4th, and 6th respectively. For full prospectuses of courses apply to Dr. GEO. TATE or Mr. GRANVILLE H. SHARPE.

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The School will open on MONDAY, 3rd OCTOBER. The Prospectus may be obtained on application by letter to the Secretary, Science and Art Department, South Kensington, S.W.

THE LONDON HOSPITAL & MEDICAL COLLEGE, MILE END, E.

The SESSION 1881-2 will commence on SATURDAY, OCTOBER 1st, 1881. Four entrance Scholarships, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Entries on or before September 20th. Fees for Lectures and Hospital Practice 90 guineas in one payment, or 100 guineas in three instalments. All resident and other hospital appointments are free. The resident appointments consist of Five House Physiciancies, Four House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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SESSION 1881-82.

I. DEPARTMENT OF SCIENCE AND ARTS.

The Session will commence on Monday, the 3rd of October, 1881.

Students under sixteen years of age will be required to pass a preliminary examination.

II. EVENING CLASSES.

These will commence on Wednesday, the 5th of October, 1881.

The Calendar of the ensuing Session, containing full information as to the aim and objects of the College and the courses of instruction, is now ready, and may be obtained from the publishers, Messrs. Cornish Brothers, Birmingham and Manchester, price 1s.

GEO. H. MORLEY, Secretary.

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THE CHEMICAL NEWS.

VOL. XLIV. No. 1141.

MINERALOGICAL NOTES.*

By B. SILLIMAN.

I. VANADINITE AND OTHER VANADATES, WULFENITE CROCOITE, VAUQUELINITE, &c., FROM ARIZONA.

I HERE record the discovery of two important and very interesting mineral localities, or districts, in the Territory of Arizona, from one of which I have obtained vanadinite of remarkable beauty of colour and perfection of crystalline form, associated with almost equally beautiful wulfenite of an orange-red colour: and from the other, four (perhaps more than four) species containing vanadium. The last named district has also furnished crocoite and vauquelinite never found before, I believe, in North America.

I am greatly indebted to my faithful and intelligent correspondent, Mr. George A. Treadwell, of Vulture, Arizona, for sending me, for some years past, a great number of minerals and ores collected by him in that Territory, among which are those now to be described. I mention also with pleasure the aid afforded me by Mr. Edward Farley, of Wickenburg, owner of several interesting veins, and Dr. Jones, of Phœnix. Mr. F. F. Thomas, lately in charge of Silverlead Furnaces, near Silent in Arizona, and Mr. John McDougal, Superintendent of Mines, have also contributed important data in extending our knowledge of that interesting Territory.

Vanadinite.—This hitherto rare species promises now to be comparatively abundant. In the so-called "Silver District," in Yuma County, Arizona, about fifty miles north of Fort Yuma, is a large area traversed by veins of quartz carrying argentiferous galena, with salts of lead, but no gold, and rather extensively explored. The lead salts which I have seen from this region are wulfenite, of remarkable beauty, vanadinite, and massive anglesite with galenite. Vanadinite occurs in three mines, near together the "Hamburg," the "Princess" and the "Red Cloud." The crystals of vanadinite are extremely beautiful, alike for billiancy of colour, lustre, and perfection of form. Only a single vanadate appears to occur in the Silver District; but there may be an exception to this remark, since a greenish yellow incrustation on one specimen may turn out to be volborthite or one of the other amorphous vanadium minerals. All the veins of this district occur, as I am informed by Mr. Thomas, between a foot-wall of granite and a hanging-wall of porphyry, specimens of which rocks I have in hand. The foot-wall of granite is somewhat irregular, but the porphyritic hanging-wall is well defined. I have not yet made sections of the latter rock; it closely resembles the augite trachytes of Nevada and elsewhere, the usual associates of silver ores the world over. All these lodes abound in calcareous matter, but there are no limestone beds in the vicinity; and in the absence of any organic remains, we are ignorant of the probable geological horizon.

"The Hamburg" mine has furnished the most numerous and, on the whole, the best specimens of vanadinite. The crystals vary in colour from deep orange-red—deeper than potassium bichromate, but not ruby—through lighter shades of orange-red to reddish-yellow and brown. They are always highly lustrous. The size is small, the length being not over two millimetres and usually less than one; and the diameter about half the length to equal dimensions. The hexagonal prisms are modified usually by one, sometimes by two, planes on each terminal edge, and occasionally the angles are replaced. These crystals are implanted singly and in crusts on a dark chocolate-coloured siliceous gangue, with occasional obscure crystals of cerussite, and rarely a dark-coloured cleavable lime-rock (impure calcite). The "Red Cloud" mine furnishes vanadinite of a rich orange-red or flame-colour, associated with beautiful orange-red wulfenite. At the depth of 280 feet, measured on the slope of the vein, wulfenite takes the place of vanadinite almost to its exclusion. The crystals of vanadinite at this mine are smaller and grouped in more confused masses than at the Hamburg mine.

At the "Princess" mine, the vanadinite occurs in slender crystals of a brilliant red colour almost identical with that of crocoite, implanted upon white calcite. The habit of the species is unlike either of those before mentioned; the crystals are at least four diameters long and are very slightly modified. They are not over half a millimetre in diameter, but are very perfect in form, lustre, and colour. They have, naturally enough, been mistaken for chromate of lead.

The genesis of the vanadates of these mines is obscure. A single small specimen only of the galena has reached me. It forms the nucleus of a surrounding mass of amorphous anglesite, upon the outer surface of which appear obscure crusts of vanadinite. Analyses of a series of samples selected on the spot, by a careful examination might reveal the origin of the vanadic acid.

Vulture District, as I have called it, another and quite distinct district in Arizona, has furnished at a number of places vanadinite with other rare species. This area embraces the country between the Hassayampa River on the west and Agua Fria on the east, and extends in a north and south direction from the well known Vulture Mine to Antelope Mountains, Weaver district, on the road to Prescott. It is partly in the lower portion of Yavapai County, and partly in the northern portion of Maricopa County. Within this area are numerous veins of gold-bearing quartz carrying lead and sometimes a little copper or perhaps both at the same time. I have become familiar with the mineralogical character of these veins through Mr. G. A. Treadwell; and Mr. Edward Farley, owner of some of the mines which have furnished the most interesting species of this area, has prepared for me a sketch map on which the localities are laid down with sufficient accuracy for identification by reference to the Government map.

Farley's "Collateral Mine," about twenty miles north-east of Vulture, is perhaps the most interesting locality of vanadinite in this area. The vein is about four and a half feet wide, and occurs in soft grey talcose rock. About one-half of the thickness of the vein, on the hanging wall side, is quartz stained green with chrysocolla, and chocolate-brown with a ground mass which I find carries vanadium, and showing lemon-yellow stains resembling plumbic ochre, also a vanadate. Any portion of these yellow and brown masses (if pulverised, digested with dilute nitric acid, and the filtrate treated with ether) gives a strong reaction for vanadic acid. Unless led to test this gangue-stone for vanadium by the occurrence of vanadinite in other parts of the vein, no suspicion of its presence would be aroused. A seam of very red ferric oxide with calcite follows next, and the red oxide of iron reacts decidedly for vanadium, while the calcite is penetrated with yellowish and white fibrous crystals of vanadinite. Next, there is a seam, of about six inches, of very soft material filled with abundant lemon-yellow acicular crystals of vanadinite in tufts and aggregated masses, the whole quite friable, forming the centre of the vein, which also carries in this zone masses of cerussite. The whole mass of this soft material reacts very strongly for vanadic acid. Then follow on the foot wall, about twenty inches of vein-matter composed of quartz with calcite. The calcite is penetrated with acicular crystals of vanadinite arranged in threads and in stellar tufts, usually not over a line in thickness, but

* Communicated by the Author. From advance sheets of the September number of *Silliman's Journal of Science.*

occasionally opening into small cavities, like geodes, lined with distinct hexagonal prisms of this species. The common colour is yellow, but they are often nearly white. The cleavage fragments of calcite carrying the vanadium crystals form specimens of rare beauty. Quartz, similar to that in the upper section of the vein, is found in this lower member, and this is also somewhat stained with copper silicates. In its open joints occur hexagonal crystals of vanadinite of a fine yellow colour; they closely resemble mimetite, but give no arsenical reaction, and I failed to obtain a trace of arsenic from the included crystals in the calcite, when tested by soda and potassium cyanide in the closed tube. This quartz carries crystals of vanadinite in habit very unlike those which occur at the Hamburg mine in the Yuma district; they are long, slender needles, hardly a line in thickness, of a delicate straw-yellow colour, quite transparent. They are associated with others of a rich orange-yellow colour and not so well defined. There are also confused tufts of crystals of the same species, not thicker than hairs, of a pure chrome-yellow colour, implanted in cavities in the red iron-stained gangue.

Descloizite (?)—A mineral which may prove to be descloizite occurs among the ores of the Collateral Mine which have reached me. It is found in blue-black and brownish-black semi-transparent and very brilliant crusts, the individuals imperfectly developed, hardness about 3—3·5, streak, yellow to brownish-yellow. Alone in the closed tube it fuses and gives off abundant water. It reacts very strongly for vanadium and for lead, also for copper, manganese, and zinc. Since this paper was in hand I have received from Mr. Farley, under date of June 25th, additional specimens of this mineral not only from the "Collateral" but also from the "Chromate" veins near the former, on one of which are seen very well defined, but very small tabular crystals, the study of which will probably show them to be the species indicated. They resemble some of the forms figured by Websky from La Plata, province of Cordoba.* We must await the arrival of more specimens before the study of this interesting mineral can be completed.

Volborthite (?)—A single well characterised specimen provisionally referred to this species came among the products of the Collateral Mines. It exists in small botryoidal masses adhering to the polished faces of deep red quartz crystals. The streak is bright yellow. In thin scales the mineral is transparent and of a clear olive-green. The lustre is vitreous and dull. No crystals were detected. Alone in the matrass it fuses readily, adhering to the glass. It gives off no water and dissolves in dilute hydrochloric acid to a greenish solution, from which alcohol throws down the lead in tufts of plumbic chloride. On charcoal it fuses to a black shining bead, which alone gives off lead fumes, and copper appears on crushing the bead in the agate mortar. With soda it gives a globule of lead enclosing one of copper. Zinc oxide stains the coal when the assay is gently heated. It may be that it will turn out to be a new species.

An anhydrous crypto-crystalline mineral containing vanadium occurs among the "Collateral" ores. It varies in colour from light yellow-brown to black-brown; gives the reactions for Domeyko's *chileite*, but it is not a clay-like mineral. It yields readily a globule of lead containing a nucleus of copper. No arsenic was found. It occurs also in the "Chromate" vein.

Gold in coarse crystalline grains occurs in the quartz of the "Collateral" vein.

The Phœnix Mine, one mile east of the mine last named, furnishes specimens similar to those just described. The vanadinite is light yellow and deep orange-yellow to reddish, in large well-formed crystals, which react for chlorine but not for arsenic. The gangue is quartz, which carries gold but no calcite in the samples which have reached me.

Among the specimens sent to me by Mr. Farley on the 25th of June, which I have just examined, I find crystals of vanadinite in the gangue of both the "Collateral" and the "Chromate" veins, quite unlike those before described and very closely resembling in habit, colour, and form the brilliant red crystals from the Hamburg mine in the Yuma Silver District.

The Montezuma lead mine, eleven miles east of Vulture and south-west of Collateral, abounds in vanadinite which occurs in drusy crusts of a rich deep yellow and brown colour on masses of cerussite. Observed with a lens these crusts are seen to be well defined hexagonal prisms. It appears to be an abundant source for the supply of vanadium.

At "the Frenchman's Mine," a gold bearing vein, of about 18 inches thickness, consists of deeply iron-stained quartz, showing amorphous yellow-green masses of a mineral very rich in vanadic acid, and reacting for lead, copper, and chlorine. It is also hydrous. It may perhaps be *mottramite*. There is a buff-coloured amorphous substance with it also rich in vanadinite. Calcite occurs in the gangue.

There are localities in this district in which vanadium is found, but the foregoing will suffice.

Mimetite occurs in considerable masses north of Domingo mine on Castle Creek in the extreme north-west of the Vulture District, as here described. I have seen only a single mass of about 80 grms. found by Mr. Farley. It was without gangue or associated species, and quite amorphous.

From "Bethesda Mine," in Los Cerillos, New Mexico, I collected in April, 1880, specimens showing greenish crusts of vanadinite in botryoidal forms and sometimes nearly black. It is there associated with wulfenite and cerussite. This vein is the southerly extension of the "Mina del Tiro," worked by Mexicans of old.

It is interesting to note the wide area over which this species is now known to exist, compared to the single locality at Zimpan, in Mexico, where Del Rio in 1803 first identified it. No doubt it will be found in equal or yet greater abundance at other localities as the work of exploration goes on. Many years since, in a paper on the Mineralogy of the Wahsatch and other Utah ranges of mountains,* I called attention to the occurrence of the molybdate of lead (wulfenite), as replacing the phosphate (pyromorphite) among the salts of lead, the latter being rarely if ever found there. Subsequently the wulfenite of Tecoma and of Eureka, in Nevada, confirmed this generalisation, and I have since had very frequent occasion to notice the wide distribution of wulfenite in New Mexico and Arizona. We may now add vanadic acid as having the same wide distribution.

Wulfenite crystals of rare beauty are found in the "Red Cloud" Mine, already mentioned as furnishing the vanadinite. The specimens sent me are from a depth of about 300 feet. They show very solid tabular crystals of large size, brilliant lustre, and rich orange-yellow to orange-red colour. The colour at once suggests the presence of vanadic acid, like the well-known specimens from Wheatley Mines as detected by Smith. But I have not found a trace of vanadic acid in these Red Cloud or other Arizona wulfenites. From the "Melissa Mine" in Silver District adjacent to the Red Cloud, wulfenite is found in octagonal prismatic forms, the basal plane being almost wanting in some specimens, giving them the appearance of simple octahedrons. This interesting form I believe has not been before observed in any American locality. The colour of the species at this locality is pure orange-red; the gangue is brown, almost black, calcite. The "Rover" is another mine of the same district which furnishes wulfenite nearly identical in form with the Red Cloud specimens, but of a little lighter orange-red colour.

Crocoite-group.—Three if not four of the species of this group occur among the ores of the Vulture region, and especially in the "Collateral" and "Chromate" veins. These two veins together with the "Blue Jay" and the "Phœnix mine" form a group of singular mineralogical interest, furnishing, among more common minerals, the

* *Monatsbericht der Akad. zu Berlin*, July, 1880, 672.

* *Am. Journ. Sci.*, III., iii., 195.

species crocoite, phœnicochroite, vauquelinite, joassite (?), vanadinite, volborthite (?), Descloizite (?), Chileite (?), wulfenite. *Vauquelinite* occurs quite abundantly associated with galenite and crocoite in a gold quartz gangue or vein stone. The genesis of the chromate is very manifest. The nucleus of unaltered galenite is surrounded with a bright pea-green and apple-green areola of vauquelinite, sometimes semi-transparent, and uncrystalline. This green mass is succeeded by crystalline and transparent crocoite of orange-red and cinnabar-red colour, giving the familiar scarlet and chrome-yellow streak. The crocoite as yet has not been found well crystallised. Besides the associated species already named, occur cerussite, gold, and magnetite. The magnetic sand collected in washing the gold out of the crushed vein stone was examined for chromite without success.

It is an interesting question, whence came the chromic acid? Perhaps an analysis of the galenite may detect chromium in that species. Smith has described a meteoric chromium sulphide, Daubréelite,* and there is no chemical reason why this species may not coexist with galenite. In the paragenesis of the chromates in this district the change has evidently proceeded from without inwards, and the occurrence of specimens in which the whole of the galenite is transformed is not unfrequent, as also the change of the crocoite to the lemon-yellow phœnicochroite.

Small orange-yellow crystals occur in the vauquelinite of the Vulture region, which may be the *joassite*; but more study is required before they can be proved to be this mineral.

In conclusion, I will add that before the study of these interesting localities can be complete a personal visit must be made by a mineralogist to the mines, and sufficient material obtained on the spot to allow of chemical analyses.

2. Thenardite from Rio Verde Arizona Territory.

Some months since I received a lump of a saline minera marked "Salt," reported by my informent, Mr. Treadwell, of Phœnix, to occur in abundance on the River Verde, in Maricopa County. It proved, on examination, to be anhydrous sodium sulphate or *thenardite*, a species which has hitherto been found in very limited quantity. In an analysis in the Sheffield laboratory under the supervision of Prof. O. D. Allen, by Dr. Geo. M. Dunham, its constitution was found to be as follows:—

	I.	II.
Chlorine	0·095	0·097
SO_3	56·410	56·310
CaO	0·120	0·130
MgO	0·021	0·023
Na_2O	[42·964]	[43·070]
Insoluble	0·390	0·370
	100·000	100·000

I. $Na_2O : SO_3 = 6·91 : 7·02$; II. $Na_2O : SO_3 = 6·93 : 7·01$.

The mineral is therefore nearly pure Na_2SO_4. The insoluble matter out, the impurities are only 0·24 per cent of the mass.

The specific gravity of a fragment quite free from visible impurity, taken in petroleum, I find to be 2·681. This mineral occurs in large masses, some of which, in the rough, are distinctly crystals with imperfect faces, showing eminent cleavage in the direction of the basal plane of the prism and a hackly cleavage in the opposite direction. The "insoluble" matter (=0·38 per cent) in the mineral—chiefly clay, gives it a prevailing shade of yellowish grey. Its hardness is below that of calcite; lustre vitreous; fracture conchoidal to hackly.

Occurring in an almost rainless country, it has suffered little change, small portions only at surface being altered to a dry white powder of exanthalose, $Na_2SO_4.2H_2O$.

As this is, so far as known, the only locality of this species where it exists in great abundance, I have taken steps to secure all the information available respecting it. Mr. Thos. F. Hopkins, of Vulture, Arizona, has forwarded to me the following statement, which I present in his own words, in a letter dated—

"Vulture Mine, A.T., June 18, 1881.

"Mr. Boyd, a resident of the Verde Valley during the past five years, is quite familiar with the large thenardite deposit, and furnishes the following details.

"The 'Salt Mine,' as it is popularly called, is situated about two and a half miles south-west of Fort Verde (the present post), on the west side of the Verde River. Squaw Peak is distant eight miles from Fort Verde, and this mine lies between these two points.

"It occurs on a 'bench' about fifty or sixty feet above the Verde River, and itself forms one of a series of benches gradually sloping toward the river. The deposit crops out boldly in the face of the bank, and seems to extend along a distance of from eight hundred to one thousand feet. It occurs in a white chalky-looking formation, and the surface opening is probably about ten feet wide. From this opening immense masses have been carried away during more than five years past, every rancher of the district taking off huge wagon loads for the use of his stock, &c. The deposit is solid, and is removed by blasting. It is not under water at any time, for both its sloping situation and its elevation above the river forbid such a condition.

"No systematic openings of the deposit have ever been made, and hence its extent is not known. It is simply 'gouged out' according to the whim and convenience of each new comer; but it seems practically inexhaustible."

I am informed by several persons who have seen this thenardite used for the salting of cattle—among them my friend Mr. James Douglass Junr., who was recently in that portion of Arizona—that the animals resort to it very freely, licking it as they are wont to do common salt, and with only good results.

Thenardite has been found in Nevada and elsewhere in the arid regions of the West Coast, but not before in sufficient quantity to be of commercial importance.

G. Vom Rath (*Zeitsch. f. Kryst.*,) lately names Lake Balschasch in Central Asia as a locality the flat shores of which furnish *thenardite* in very considerable quantity.

* *Am. Journ. Sci.*, III., xii., 109.

On the

COLORIMETRICAL ESTIMATION OF CARBON IN IRON.

By Prof. EGGERTZ.

In the working out of this method as described in the *Jern Kontorets Annaler*, 1862, p. 54, with some additions made in 1874, p. 176, I believed that the amount of carbon estimated with an accuracy of about 0·1 per cent, would fulfil all practical purposes; but claims upon it have afterwards arisen, and it seems now to require an exactness of a little more than 0·01 per cent.

Meanwhile the iron sent out in commerce is usually stamped with only whole and half-tenths of the percentage of carbon, and it is specially for the softest kinds of iron, with carbon between 0·1 and 0·25 per cent, which appears to claim a greater precision in carbon estimation.

When pure ferric hydrate free from chlorine, containing 0·1 grm. iron, is dissolved in 2·5 c.c. nitric acid, free from chlorine, and 1·2 sp. gr., a yellow green solution is got, when, put into a burette as commonly used for colorimetric carbon testing, about 12 m.m. diameter, and a further addition of 1·5 c.c. nitric acid made, it clears somewhat, but not so much as when water is added instead of nitric acid. The warm solution has a much stronger colour than the cold. Add afterwards in both cases 4 c.c. water, so that the volume of the solution amounts to 8 c.c. Note now that the iron colour has gone. It

follows, as a rule in colorimetric carbon testing, that the iron solution is to be diluted with at *least* the same quantity of water as of nitric acid used for solution, also that the volume of the solution never ought to exceed 8 c.c. when the colour is read off.

The nitric acid as well as the diluting water ought to be free from chlorine or hydrochloric acid. Whenever a very slight trace of such is present it communicates to the iron solution a yellowish colour.* The quantity of nitric acid required for solution is regulated to a certain degree by the supposed amount of carbon in the iron. Thus, employ for solution of iron with a lower amount of carbon than 0·25 per cent, only 2·5 c.c. nitric acid, with carbon of 0·3 per cent use 3 c.c., with carbon 0·5 per cent use 3·5 c.c., and for carbon 0·8 per cent use 4 c.c. nitric acid. For steel with a greater amount of carbon take 5 c.c. nitric acid, as also for white cast-iron, but only 0·05 grm. of it should be weighed, with great accuracy.

When the amount of carbon is altogether unknown, begin with 2·5 c.c. nitric acid, and afterwards add more as soon as the colour of the solution, or the amount of separated carbon, shows that more acid is required. A little more acid than here given does no harm, only afterwards add at least the same volume of water, and for white cast-iron 7 c.c. may be taken to prevent the quick precipitation of a humus-like substance after dilution. If too little acid has been used, the solution will have too deep a shade. For example, if steel of 0·8 per cent carbon is dissolved in only 2·5 c.c. nitric acid, instead of 4 c.c., the colour of the solution after dilution will correspond with that of a steel containing about 0·9 per cent carbon.

The iron to be tested must be finely divided either by filing by means of a clean and sharp file;† or, better, by boreing or planing by means of a steel edge, for which an old three-cornered file can be adapted by grinding off the teeth, and furnishing with a handle at each end; or, if very hard, crush the iron in a steel mortar.

For solution of the iron use test-tubes of about 15 m.m. diameter and 120 m.m. long; dry with clean clippings of filter-paper thickly rolled together. Transfer into the test-tube from the weighing scoop with the help of a hair pencil the accurately weighed amount of iron, 0·1 grm., or, if white cast-iron, 0·05 grm.; then add 2·5 c.c. or more nitric acid of 1·2 sp. gr., and free from chlorine. The measuring of the acid can be best done by means of a small pipette, 10 m.m. diameter, graduated to whole and half cubic centimetres. The test-tube is covered with a small watch-glass (23 m.m. diameter), and it is now placed into a cylindrical copper dish, 100 m.m. deep, and at least 120 m.m. diameter; upon this is placed a copper lid furnished with a thermometer tube hole, and holes for the test-tubes, marked with numbers. The dish is previously provided with water, also some grammes of paraffin wax to hinder evaporation. Heat up the dish over a gas or spirit flame to 80°, and maintain at this temperature the whole time. Shake the tube while the iron is dissolving. Solution is ended when no gas bubbles are evolved; this may require one and a half to two hours, or sometimes more, according to the amount of carbon in the iron.

This has been the ordinary method followed hitherto, but experience has shown that the maintaining of the temperature of 80° demanded attention which could by no means be always given. It was also of less consequence whether or no a normal solution was dissolved every time in the same manner as the iron whose carbon contents was to be estimated. But if this is to be avoided, and unchangeable normal solutions used as described under, the solution must he always made at the same temperature, and to this end it is safer to place the test-tube in boiling water. By this method the time for solution is shortened to about three-quarters of an hour, and the colour of the solution will be a little stronger than by dissolving at 80°. If an occasional necessity calls for still greater speed, the solution can be made in about a quarter of an hour by means of gentle boiling over a lamp flame, between which and the test-tube a suitable brass wire gauze is placed, on which the tube may rest, but the colour of this solution will commonly be a little darker than when using the temperature of 100°. The reason for employing 80° instead of 100° was, that at the latter temperature a reddish yellow sublimate-like film was obtained in the tube, which afterwards came into the solution and made it dim. When such happens, try to dissolve the film in the solution by violent shaking, and if this is not successful, filter it off. The film is composed only of nitric acid and ferric oxide, as it appears in heating pure ferric hydrate in nitric acid.

As soon as all evolution of gas ceases, take out the test-tube and place in a beaker with water to cool, when it ought to be covered with a cap of pasteboard to protect it from daylight, by which the solution is soon bleached. When protected from light in this manner the solution maintains its colour for several days. The burettes employed for carbon estimations ought to have a volume of 30 c.c., and be graduated in 1-10th c.c. also, furnished with an opening and spout. The solution is then placed in the burette, which may be done through the filter. If the solution is not clear, or graphite is present, at least an equal amount of distilled water (including the wash-water from the test-tube used for boiling) must be added to the nitric acid used, and the volume made up to at least 8 c.c. before comparison with the normal solution. The normal steel is prepared in like manner, and diluted with so much water that every c.c. of it corresponds to 0·1 per cent carbon; this can afterwards, by careful dilution with water, be made of such strength that every c.c. corresponds to 0·05, 0·02, 0·01, or 0·005 per cent carbon in 0·1 grm. iron. From normal steel with, for example, 0·80 per cent carbon, dissolve 0·1 grm. in 4 c.c. nitric acid, and dilute with water to 8 c.c. Mix carefully after every dilution, because the lower strata of the solution will otherwise be of too deep a colour. Before reading off (which is done from the upper edge of the solution) allow it at least one minute to flow down from the sides of the burette.

The above-named special normal solutions can be marked and employed as follows:—

	Carbon per cent per c.c. of 0·1 grm. Iron.	Used for Iron with Carbon per cent.
Normal ..	0·10	0·8 and higher
½ N ..	0·05	0·4 to 0·8
1-5th N ..	0·02	0·16 to 0·5
1-10th N ..	0·01	0·08 to 0·25
1-20th N ..	0·005	0·04 to 0·08

The lowest amount of carbon found in any iron is 0·04 per cent,* and in employing the last-named normal solution, good daylight is required; this is also best for all colorimetric testing.

Greater dilution than twenty times cannot be used in common burettes of about 12 m.m. diameter, but by using tubes of 24 m.m. diameter, the difference is well marked between a forty times diluted normal solution and distilled water, and in this way approximate estimations ought to be made of carbon in iron of about 0·02 per cent in the case of iron so poor in carbon being produced. Measure in a small pipette 1 c.c. normal solution, dilute to 40 c.c. corresponding to 0·0025 per cent carbon per c.c.; introduce this into a 24 m m. test-tube, which accurately agrees with another graduated tube, in which 0·4 grm. iron is dissolved in 10 c.c. nitric acid, and diluted with

* Only 0·0001 grm. chlorine in a solution of 0·1 grm. iron from ferric hydrate in 2·5 c.c. nitric acid produces a decided yellow colour. Dilute this solution with 1·5 c.c. nitric acid and 4 c.c. water, the colour is still observed, but less in proportion as the solution is diluted.

† Through the wearing of the file the amount of carbon in the iron can be considerably increased.

* By means of the iodine method, in a sample of 8 grms. of Lancashire hearth iron, 0·038 per cent carbon was obtained.

water first to 32 c.c., and then, further, till their colours agree. Should such happen, for example, when the volume of the solution is 35 c.c., the amount of carbon in the iron will be $0{\cdot}0025 \times 35 : 4 = 0{\cdot}022$ per cent.

In comparing the solutions with each other by the method hitherto commonly used, in which a thin paper-filter is held behind the tube, it has been seen that much depends on the distribution of the light in the apartment, and that a room with only one window is best. Before most eyes it is seen, however, that the tube held on the right is a little weaker in colour than that placed on the left; therefore, as also prescribed from the first, the burette containing the assay should always be held in like manner, or to the right. That we may be more independent on the nature of the room, and equalise the difference in colour caused by placing the tubes to the right or left, I have with great advantage now begun to use a little camera in which the tubes are placed. This is made of deal 6 m.m. thick, in the form of a box open in both ends, blackened inside. The height inside is 80 m.m., the breadth in front 26 m.m., at the back 120 m.m. The front of the upper side is cut out to insert the tubes, and these are kept in their places by means of a brass wire fixed in the upper front edge; also by a little trough of sheet copper on the lower outer edge. The opening is covered with a thin filter-paper fastened with a pin.* The burette and test-tube must in respect to the quality of the glass agree exactly in colour, and be dried outside with clean cloth before placing in the camera.

As normal steel and normal iron, two sorts made by the Bessemer process have been used lately, one adopted with 0·80 and the other with 0·16 per cent carbon. The size is 12 m.m. square, and testing shavings are always taken at right angles to its length. The carbon has been estimated by the iodine method as described in *Jern Kontorets Annaler*, 1862, p. 47, and 5 grms. taken for every testing. From this steel three estimations gave 0·79, 0·80, and 0·82 per cent carbon, and from the iron 0·16 was obtained in two closely-agreeing estimations. These carbon estimations have also agreed with the combustion analyses executed by Dr. A. Tamm in iron and steel with the nearest comparable amounts of carbon, as mentioned in the *Jern Kontorets Annaler*, 1874. Instead of immediately employing iodine, as was done at first, and in view of the difficulty of obtaining it pure, for these estimations iodine dissolved in iodide of iron has been used. This solution is prepared by adding to a solution of 10 grms. of iron in 50 grms. iodine, further 50 grms. iodine, in which it is quickly dissolved, then filter the solution into a measure, pass water through the filter till the volume is 100 c.c. One gramme iron requires 10 c.c. of this solution. In consequence of the loss of weight in treating filter-paper with acids, platinum filters have been used to take up the carbon mass; but it is difficult to obtain them good. It appears that inconvenience is removed by using filter-paper treated with hydrochloric acid and hydrofluoric acid (see *Fresenius Zeitschrift*, 1879. p. 582), by which the inorganic components are nearly completely extracted. One of these filters 60 m.m. diameter gave less than 0·0001 grm. ash. Drying of the carbon mass is safest done in a water-bath at a temperature of 95° to 98°, wherein the crucible is placed in a test-tube of about 130 m.m. long and 35 m.m. diameter; the open end is closed with a cork through which passes a thermometer. By means of a bent brass wire the crucible can be inserted and drawn out.

With white cast-iron the colorimetric method has given better results than could at first be expected (see *Jern Kontorets Annaler*, 1874. p. 177), when only 0·05 is taken for testing, yet the solution must be diluted to a larger volume, whereby a little error in observation in respect to the colour will have a great influence. These solutions ought to be quickly read off, because they soon become a little dim from a humus-like substance which precipitates. By using for solution 7 instead of 5 c.c. nitric acid this inconvenience is lessened.

The different nature of the carbon, such as the so-called cement carbon, and hardening carbon has not made itself known in any other way in colorimetric testing than that the colour of the solution of the latter is less than the former, so that a steel of 0·8 per cent carbon, after strongly hardening and pulverising, gives only 0·55 per cent. After heating the hardened steel to a brown heat, the original amount of carbon is again found. By the iodine process on 5 grms. of the hardened steel 0·8 per cent carbon was obtained. Iron with 0·3 per cent carbon, reduced by cold hammering from 12 to 6 m.m. thickness, showed the same amount of carbon.

During solution the various sorts of iron behaves with so wide a difference that the solution will sometimes be coloured instantly, at other times only after a little warming. The final colour after dilution with water will usually agree very well with the colour of the normal solution. Should any little inequality of colour remain (such as approaching to yellow or brown) less regard ought to be fixed on it than on the intensity of the colour, or on the distinctness with which the small inequalities in the paper held behind the test-tubes can be seen. From the nature of the case it follows that individuals with more or less good eyesight are found to perform these tests with more or less sharpness, but experience has also shown that the ability to see in this respect can be considerably improved by practice, and at most only few persons have found it impossible to do this work.

With reference to the presence of foreign substances in iron, and their influence upon the colour of the solution the following experiments have been made:—

Manganese, 0·05 grm., in the form of carbonate, dissolved in 2·5 and in 5 c.c. nitric acid with a brown colour, from the presence of a little manganese oxide. Heating to 100° produced a little precipitate (probably from hydrate of manganese peroxide); thereafter the solution had only a weak red-violet colour, which on diluting with water to 8 or 10 c.c. could be regarded as vanished. It seems from this that the colorimetric method would be serviceable for the estimation of the amount of carbon in ferro-manganese. One sample of such with about 80 per cent manganese showed carbon approximately 4 per cent.

Phosphorus, 0·001 grm. in the form of soda phosphate added to a solution of 0·1 grm. iron as ferric hydrate in 2·5 c.c. nitric acid and 2·5 c.c. water, showed no difference in colour with a similar solution without phosphorus. Iron with 5 per cent phosphorus is difficultly soluble, and with 10 per cent phosphorus insoluble in nitric acid.

Sulphur, 0·001 grm. in the form of magnesium sulphate, added to 0·1 grm. iron, dissolved in 2·5 c.c. nitric acid and 2·5 c.c. water, was without influence.

0·01 grm. manganese, 0·01 grm. phosphorus, and 0·001 grm. sulphur (all in the forms given above), added to a solution of 0·1 grm. iron as ferric hydrate in 5 c.c. nitric acid and 5 c.c. water, showed no colour. The same quantities added to 0·1 grm. normal steel with 0·8 per cent carbon, dissolved as usual, made no change in the solution or in its colour.

Copper, 0·001 grm., dissolved in 2·5 c.c. nitric acid and 2·5 c.c. water, gave no colour to the solution.

Silicon in iron dissolves to a considerable amount in nitric acid on warming, and particles of silica begin to appear in the solution. 0·4 per cent silicon in steel has at least not shown any influence in colorimetric testing. In cast-iron rich in silicon graphite is always present, and must, with possibly the insoluble silica, be filtered off.

Tungsten becomes tungstic acid on dissolving the iron; it is then insoluble and must be filtered off.

Chromium, 0·002 grm. in the form of chromic hydrate, dissolved in 2·5 c.c. nitric acid and 2·5 c.c. water, gives to the solution a greyish blue colour, which on dilution with water to double its volume is less noticeable. On greater dilution the colour diminishes, and when diluted to 40 c.c.

* The wide opening of the camera can, if desired, be covered by a screen, in the centre of which is placed a suitable convex or concave glass of about 40 m.m. diameter.

may be said to disappear. Iron containing much chromium is difficultly soluble, or even insoluble, in nitric acid.

Vanadium, 0·001 grm. in the form of vanadic acid, dissolved in 2·5 c.c. nitric acid, gives to the solution a weak yellowish colour, which disappears on addition of 2·5 c.c. water.

Nickel, 0·001 grm., dissolved in 2·5 c.c. nitric acid, gives a green colour on solution, which is still apparent on addition of 2·5 c.c. water, but can be regarded as absent on diluting to 8 or 10 c.c.

Cobalt, 0·001 grm., dissolved in 2·5 c.c. nitric acid, gives, as is well known, a red-coloured solution, which is little noticeable on dilution with water to 24 c.c., but scarcely can be regarded as absent before dilution to 40 c.c.

In my note of 1862, I showed the desirability of obtaining from inorganic substances unchangeable normal solutions, instead of those of burnt sugar in spirit used by me which bleached with time, and this the quicker in proportion as they were more often exposed to sunlight. Several proposals with this object have been brought forward lately, in which iron, cobalt, and nickel salts, bichromate of potash, &c., have been recommended. After experimenting with several such mixtures, I have, upon the suggestion of Prof. F. L. Ekman, tried chlorides of iron, cobalt, and copper, which give the best results, because with them we can, as desired, produce colour tones in yellow, brown, and green. Such mixtures, diluted with water, containing 0·5 per cent hydrochloric acid of 1·12 sp. gr., have been found stable, even after standing a long time in sunlight. By only adding hydrochloric acid in drops the mixture is strongly drawn towards yellow. From the neutral chlorides I have, by adding water containing 1·5 per cent hydrochloric acid for ferric chloride, and 0·5 per cent for both the other salts, prepared solutions of such strength that they contained 0·01 grm. metal per c.c. Then taking of these solutions 8 c.c. iron solution, 6 c.c. cobalt solution, 3 c c. copper solution, and about 5 c.c. water containing 0·5 per cent hydrochloric acid, a mixture has been obtained of a colour entirely similar to a solution in dilute nitric acid, of iron containing carbon corresponding to 0·1 per cent per c.c. This solution can afterwards be diluted with water containing 0·5 per cent hydrochloric acid to whatever normal colour is desired, and the water added in the nearest proportion with the amount of carbon. It may be necessary to bear in mind that the weights of 0·1 and 0·05 grm. for weighing off the iron must be very accurate when such artificial normal solutions are used.

Now that unchangeable normal solutions can be obtained, the time may now be come for those desiring such to apply the old method used for copper estimation in ammonia solutions, as adopted by J. B. Britton, of Philadelphia, for colorimetric carbon estimations in iron.* He employed a number of tubes alike in size, containing equal volumes of normal solutions of different strengths; and dissolved the iron in a similar tube, and diluted with water to the same volume as the normal solutions. By comparison with these he can at once tell the amount of carbon, and thus avoid the inconvenience of the successive dilutions. Mr. Britton uses fifteen separate normal solutions for carbon amounts between 0·02 and 0·3 per cent, and he says by taking 1 to 2 grms. iron for estimation the carbon can be determined to an accuracy of 0·01 per cent. He uses for his normal solutions roasted coffee, which he found better than burnt sugar.

A greater exactness in colorimetric carbon estimations may be gained by observing the solutions in the tube from above instead of from the side; but for this purpose it is necessary that the tubes completely correspond at the bottom, that they are obtained suitably clear, and that the depth in all the tubes are alike.

By these observations now communicated I hope that the difficulties which sometimes appeared in colorimetric carbon estimations, both here and elsewhere, may be in some degree removed. At the same time it ought to be remembered that the essential properties of iron and steel do not exclusively depend on the amount of carbon.

I gratefully acknowledge the assistance rendered me by Mr. C. G. Dahlerus in the above estimations.—*Jern Kontorets Annaler*, 1881, Part 5, p. 301.

* Chemical News, Aug. 26, 1870, vol. 22, p. 101,

NOTES ON WATER ANALYSIS.

By A. WAGNER.

I. Notes on the Determination of the Solid Residues.

If about half a litre of the water under examination is very slowly evaporated in small porcelain or platinum capsules over a gas flame turned so low that its point does not touch the wire gauze under the capsule, we find—at least with the Munich gas—that the part of the capsule turned towards the flame appears after the evaporation of a blackish grey colour, the meshes of the wire being often plainly to be recognised. This coating might be taken for soot, but if the capsule is exposed to the air for some time this layer becomes smeary and moist, and if touched with the tongue has an intensely acid taste. It is evidently sulphuric acid and ammonium sulphate, due to the sulphur present in the gas. With a platinum capsule this deposit is more considerable than with a porcelain capsule. If it is not removed before weighing the residue of the evaporation a notable error may be occasioned. To wipe off the deposit, especially with a platinum capsule, is always doubtful.

For this reason, when evaporating the water, I place below the capsule, instead of a wire gauze, a thin piece of sheet platinum, so that the bottom is entirely protected. The following experiment shows the importance of this precaution:—Two half litres of water were simultaneously evaporated in platinum capsules, No. 1 being placed over a piece of wire gauze and No. 2 upon sheet-platinum. On weighing the two residues, after drying at 150°, that of No. 1 was the heavier by 12 m.g. If the dry residue is used for determining the organic matter in the water by ignition, the aforesaid coating of sulphuric acid and ammonium sulphate is expelled by the heat, and thereby the quantity of organic matter is made to appear too large.

II. Remarks on the Determination of the Organic Matter.

In performing a complete quantitative analysis of drinking-water it is necessary to give an absolute figure for the quantity of the organic matter. The chemist is thus compelled to give a numerical result which he cannot possibly guarantee, as up to the present time there does not exist any practicable method for the certain determination of the organic ingredients of a water.

Kubel and Tiemann remark with perfect truth that a determination of the organic matter in water is impossible until we know what is to be determined.

Formerly, when there was no practicable method for the determination of nitrates in spring-water, it was customary to get over the difficulty by maintaining that nitrates were either totally absent in such waters or present merely in quantities which might be neglected—an assertion which has been thoroughly refuted by numerous analyses of the water of different towns. Similar was the case with the determination of organic substances. They were simply described as crenic and apo-crenic acids, perfectly harmless, and it was assumed that in consequence of the absorbent and oxidising properties of the soil, the constituents of urine, &c., could not occur in spring-water.

The nature of the organic matter in such water is far more complicated. Scherer and Fresenius found in the mineral springs of Brückenau and Weilbach butyric and propionic acid. It is also undeniable that in populous places the ground-water is directly polluted by the constituents of human and animal excretions, whether un-

changed or putrescent, owing to the leakage from sewers and cesspools. Thus I found for years at Munich, in the water of a group of wells, all the characteristics of the urine of horses. On account of the introduction of town sewage into rivers, their waters must hold in solution matters very different from harmless crenic acid. According to Kubel and Tiemann a part of the organic matters contained in Berlin spring-waters is of the nature of organic bases, with which a part of the acids present in the water is of course combined. For the Munich waters I must, after long experience, consider it as certain that a part of the organic matter of the spring water consists of organic acids, combined with bases. If a large quantity of Munich spring-water is evaporated to dryness, the residue treated with distilled water, and in the soluble portion the mineral acids and bases, including ammonia, are carefully determined, there is generally found a larger proportion of bases than corresponds to the mineral acids. That this excess of bases does not consist of re-dissolved calcium or magnesium carbonate appears from the fact that if the soluble portion is re-evaporated to dryness the residue does not effervesce with dilute acids. A part of the organic matter must therefore consist of acids, combined with bases.

The methods proposed for the quantitative determination of the organic matters depend on different principles.

Frankland and Armstrong seek to determine the quantity of organic matter by ultimate analysis, and calculate from the carbonic acid found, on the assumption that humoid bodies contain 58 per cent of carbon. This process is only admissible when proof can be furnished that the water in question contains no organic matter save such as is of a humoid nature. In the analysis of the well-waters of populous city districts, or of river-waters which have received town sewage or the waste waters of manufactures, this method is completely excluded.

The same conclusion holds good of the methods which depend upon the reduction of silver oxide or potassium permanganate. Such methods give a datum for expressing comparatively the safety of a water, but they do not enable us to advance a definite number for the absolute weight of the organic matters present. In the permanganate process the organic matter is found by multiplying by 5 the quantity of permanganate consumed. Concerning this procedure, Kubel and Tiemann are of opinion that it can no longer be upheld. To show what strange results may be obtained by the use of such methods I will give, as a curiosity, the following example:—In an investigation, to which a prize was awarded by the University of Munich, and which is published in the *Zeitschrift für Biologie*, 14, 190-280, there are cited many analyses of waters, where the organic matters are thus calculated:—

Canal water: residue on evaporation, 0·466 per litre; organic matter, 1·063; lime, 0·146.

Hofgrabenbach: residue on evaporation, 0·468; organic matter, 0·496; lime, 0·105.

Hence this useless procedure shows the organic matter as considerably greater than the whole solid residue, though salts of lime and other mineral matters were present.

If it is compulsory to express the quantity of organic matter in a sample of water by an absolute figure, I consider it incumbent upon the chemist to state by what process such number has been obtained, and to explain to the lay public that such numbers must be considered and compared with due caution.

As the simple loss on ignition is never decisive, I consider the following process the most suitable for the determination of organic matter. It has proved very satisfactory for the Munich waters, which contain calcium carbonate as a greatly predominating constituent.

After the determination of all the other constituents of the water, I evaporate suitable quantities to dryness, and separate the dry residue by means of distilled water into an insoluble and a soluble portion, which latter contains the chief bulk of the organic bodies. In the insoluble portion, which in the waters of this district consists almost entirely of calcium and magnesium carbonates, I determine the organic matter by igniting a dried specimen in a platinum capsule and treating subsequently with ammonium carbonate in the customary manner. The portion soluble in water, if nitrates are absent, or present only in a quantity too small to be determined, is dried after evaporation in a platinum capsule, weighed, heated to a very low redness, and weighed again. But if the nitrates are present in larger quantities, so that the existing organic matter would not suffice to convert the nitrates into carbonates, I add to the soluble portion, after drying and weighing, a little pure solution of sugar, evaporate to dryness, and heat the platinum capsule gradually and by piecemeal with a very small gas flame, so that no deflagration may happen. After prolonged but very gentle ignition the sugar-charcoal is found burnt away, when the residue is moistened with water containing carbonic acid, and weighed again after drying. The loss of weight in this case expresses the weight of the organic substances and the difference between the equivalent of the nitric acid which was present, and of the carbonic acid which has taken its place. This difference can be easily calculated from the quantity of the nitrates, as previously ascertained, and must be deducted.

This process is of course by no means absolutely accurrate, since on ignition not merely carbonates, but cyanides may be formed, and since carbon reduces the sulphates, which on subsequent ignition with access of air are not certainly and completely re-oxidised. If the temperature is raised too high a loss of the alkalies is possible.—*Zeitschrift für Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 5, 1881.

E. W. Binney, F.R.S., F.G.S., President in the Chair.

The President said that he had, on several occasions brought before the Society a notice of the *Eucalyptus globulus* growing near to the sea in his garden at Douglas, in the Isle of Man. It was planted in 1875, and grew about 7 feet in height annually during the three following years; after these its top reached higher than the wall sheltering it, and it was exposed to the east winds from the sea, which stopped its rapid growth. It has attained a height of thirty feet. During the winter it fared pretty well until the beginning of March, when the strong gales made bad work with its foliage, but the tree is still alive, and he has every hope it will rally again in the summer. It grows about six feet above the ordinary high water mark of the sea in Douglas Bay.

"*Note on the Presence of Arsenic in Paper Hangings*," by Harry Grimshaw, F.C.S.

That arsenic in various states of combination is very often present in the colouring matter of paperhangings is a very well ascertained fact. That it is not confined, as was at one time generally supposed, to those papers which are coloured green, is also pretty well understood, many chemists having found it in papers of all shades and colours, including even white and grey.

A case which illustrates very well this general distribution of arsenic in papers of various colours and shades, and also illustrates one or two other interesting features in connection with this subject, has been brought under my notice by Mr. R. Le Neve Foster, F.C.S., and it will perhaps be of some little interest to this Society. One of the two series of specimens of wall paper which I now show you consists of six papers of varying colours. Three greens, of different shades, light brown, dark brown, and

pink, are the tints comprised, and all of them without exception contain arsenic largely. The pink, which is a very light shade, contains the least arsenic, and the brightest green contains the most, though one of the brown shades contains a very large amount. I have not determined the amount of arsenic quantitatively, as that was not needed to condemn the papers, but probably the pink paper contains a sufficiently large quantity of arsenic on one square foot to poison an adult person.

When these papers were selected from a Lancashire manufacturer it was particularly specified that they should be free from arsenic. The absence of this body was assured in a positive manner, and no doubt the papers would have been definitely guaranteed to be absolutely free from arsenic. This assurance, however, from previous experience, was not relied on, and the papers were qualitatively analysed for arsenic with the result above stated.

The injurious effects which might have resulted, in fact would almost certainly have resulted, from papering six rooms in a house with arsenical paperhangings, do not need enlarging upon any more than does the almost criminal foolishness of stating that such papers were free from arsenic.

The second series of six samples which I have placed along with the six arsenical papers illustrates very conclusively the fact that arsenical compounds are certainly not essential to the production of the colours required in the decoration of paper. These second papers were obtained from a London manufacturer to replace those which I have described, and will be seen to be so near them in shade and colour that in one or two cases it is difficult to perceive any difference at all. None of the second series of papers yield the least indication of arsenic with Marsh's test, and therefore entirely justify their warrant as free from arsenic, and were of course selected for use. We have therefore in these six self-tinted papers and the two-patterned papers, which I have also here, tints which alone or in combination will serve to demonstrate that any colour almost which is desired can be obtained without the addition of arsenic. If there is a difference in the appearance of the arsenical and non-arsenical colours, it is that the former are rather brighter. This, however, is not altogether a merit, for wall colours may very easily be *too bright*.

It is to be regretted that non-arsenical paperhangings are at present, as a rule, somewhat dearer than the ordinary ones, but there is not much reason to doubt that this will be materially changed when the former are more largely made and used than at present. The cheapness of arsenic and its compounds is an unfortunate circumstance which favours its adoption, but when it is more generally acknowledged that the "brightness" yielded by these arsenical colours is not at all indispensable, this cheapness will not be an insuperable objection.

In papers which contain arsenic the hardness of the surface and the comparative firmness with which the colour is fixed on the paper are of course important factors in the danger which attends their use; a paper on which the colour is but loosely attached, though it may contain less arsenic, will be much more dangerous than one containing a much larger amount with the colour firmly adherent, the minimum of danger being reached in a "glazed" paper or a sized and varnished one. In any case, however, a sensible person will prefer not to live continually surrounded by so many square feet of arsenic-covered walls, and it is to be hoped that the promiscuous use of arsenical paperhangings will receive a permament check on the completion of the labours of the Committee of the Society of Arts, which is, I understand, at present drafting an Act of Parliament to regulate the application of this poisonous substance, and endeavouring to decide upon a test to which suspected papers may be uniformly subjected.

It is not a point to congratulate ourselves upon, that it appears to be the opinion that the Lancashire paperhanging manufacturers have the unenviable reputation of being greater offenders with respect to the presence of arsenic in papers than their fellows nearer the metropolis, and there can be no necessity, with the local scientific and technological knowledge which is attainable, that this should be the case.

It appears to be a moot point whether the cheaper or the more expensive papers usually contain more arsenic, and also in which class is it oftenest found. I hope to have an opportunity of making a communication to the Society on this point on a future occasion.

Dr. Joule, F.R.S., said that since Mr. Grimshaw read his paper on the sulphuric acid produced by gas lights, he had hung two finely perforated zinc plates over one of his burners. The nearest plate was 12 inches above the flame, the other 3 inches above it. The burner was a large one, and lighted on the average five hours each day. The zinc plates were examined after three months, when it was found that the lower one had accumulated the usual brownish black deposit and also a furring of sulphate of zinc. The upper plate of zinc was little affected, which leads him to the belief that a single plate of perforated zinc of about a foot square is sufficient to remove the greatest part of the noxious emanations, and obviates to a great extent the necessity of a globe or chimney.

"*On the Relation of Electrical Resistance to the Chemical Composition of Steel Wire*," by William H. Johnson, B.Sc.

I showed in a paper read before the Society in March last year, and entitled "On the Electrical Resistance and its Relation to the Tensile Strain and other Mechanical Properties of Iron and Steel Wire," that in cast-steel wires drawn in the same way but manufactured so as to contain different quantities of carbon, &c., the electrical resistance increased with the resistance to tensile strain; *vide* Table B in the report of my paper (*Proceedings of the Manchester Lit. and Phil. Society*, No. 12, vol. xix.

During the last year Dr. Burghardt has very carefully analysed the identical samples of annealed steel wire whose electrical resistance and other mechanical tests are given in Table B just mentioned. The results for all samples with the exception of No. 6, not yet analysed, are shown in Table C.

A glance at this table shows us that five of the samples have only four elements other than iron present in quantity, namely, carbon in two forms combined and graphite, silicon and manganese, and traces only of sulphur and phosphorus.

Now, how do these elements effect the conductivity of the steel? Let us examine them in detail.

First, graphite carbon must be present in the steel as a mechanical mixture, and so can scarcely exercise any influence on the conductivity. Then manganese will probably be present in the form of an oxide; as manganese oxidises at the high temperatures steel is cast more readily than any of the other constituents of the steel. Now, oxide of manganese can hardly be present in the steel other than as a mechanical mixture, and thus we may disregard its influence.

There are now left combined carbon and silicon, and in Samples 1 and 2 a little sulphur or phosphorus. From analogy with copper, sulphur and phosphorus should increase the electrical resistance of iron very much. Perhaps we may estimate in a rough way the total effect of these elements on the conductivity by taking their sum as shown at foot of Table C. If this is correct, we are led to the interesting result that within the range of these experiments any increase in the percentage of sulphur, phosphorus, carbon, and silicon present in a steel is accompanied by an increase in its electrical resistance, and, further, an increased electrical resistance is concurrent with an increase in the resistance to tensile strain.

The quantity of carbon, silicon, sulphur, and manganese in the samples of steel is so very small that the most careful analyses give results which must be regarded as approximate rather than definite; hence I have much diffidence in laying these figures before you. But however

TABLE C.

Analysis of Cast-Steel Wires, Nos. 1 to 8, and Electrical Tests as given in Table B, "Proc. Man. Lit. and Phil. Soc., March, 1880.

Sample No.	1.	2.	3.	4.	5.	7.	8.
Metallic iron	98·980	99·070	98·870	98·880	99·030	99·170	99·007
Combined carbon	0·391	0·438	0·270	0·280	0·182	0·226	0·268
Graphite carbon	0·040	0·060	0·150	0 150	0·130	0·150	0·080
Silicon	0·157	0 011	0·190	0·150	0·140	0·080	0·033
Manganese	0·088	0·300	0·470	0·410	0·390	0·340	0·380
Sulphur	0·080	0·031	trace	trace	trace	trace	trace
Phosphorus	0·096	trace	trace	trace	trace	trace	trace
Total	99·832	99·910	99·950	99·870	99·872	99·966	99·768
Combined carbon, silicon, sulphur, and phosphorus	0·724	0·479	0·460	0·430	0·322	0·306	0·301
Electrical resistance of annealed steel wire in Ohm's per metre gramme	2·140	1·903	1·560	1·519	1·450	1·430	1·070

much the ultimate accuracy of these figures may be called in question, I think we may fairly say that the electrical resistance of a piece of iron or steel is a measure of its resistance to tensile strain and of the amount of combined carbon, sulphur, silicon, and phosphorus it contains.

NOTICES OF BOOKS.

Essays on the Floating Matter of the Air in relation to Putrefaction and Infection. By JOHN TYNDALL, F.R.S. London: Longmans, Green, and Co.

THE immediate objects of the work before us cannot be ranked as chemical or physical. The researches here described concern the vexed question of abiogenesis or spontaneous generation. In the interest of practical surgery and of preventive medicine it is exceedingly important to know whether low forms of organic life, and especially morbific bacteria, micrococci, and the like, can appear spontaneously in a fluid or solid affording a suitable pabulum, or whether even in their case the saying *omne vivum ex ovo* holds strictly good. Prof. Tyndall adopts the latter view. Without denying the possibility of spontaneous generation, he contents himself with showing that all the evidence advanced in its favour is untrustworthy, and depends on errors of observation. As a specimen of a carefully conducted experimental enquiry and of inductive reasoning this work may be advantageously studied, even by such as have no especial interest in its subject-matter.

The contention of the advocates of abiogenesis is that the living organisms which sooner or later appear in the decoctions of animal and vegetable matter are absolutely spontaneous. Their opponents maintain that all such life has its origin in germs or spores introduced from the air adhering to the vessels, or present in the water used in making the infusions or solutions. To decide the question is an exceedingly delicate matter, seeing that we have to do with spores or germs not merely invisible to the naked eye, but so small as often to elude the microscope. The first experiment made was to place the organic liquid in a narrow-necked flask, to boil for a considerable time, seal the neck before the blowpipe, and await the result. The abiogenists contend that if life appears in a solution which has been thus treated it must be regarded as of spontaneous origin. As, in fact, life was frequently manifested in such liquids they claimed a triumph. But the researches of Drysdale and Dallinger, who have carried microscopic research to a degree of perfection previously unknown, show that though a boiling heat destroys mature bacteria, the germs of these beings have a power of resisting heat greater in the proportion of 11 to 6. The sugestion was then made that if an organic liquid was heated not once, but repeatedly, the germs present would be successively destroyed as they reached the adult state, and the solution would finally be sterilised. When this is done without any flaw in the process the result is as expected. But the precautions requisite are exceedingly minute and tedious. Prof. Tyndall has in some cases prepared his flasks and tubes for boiling experimental solutions by washing first with carbolic acid, then with caustic soda, then with distilled water, and lastly heats them to redness. Sometimes the contents of a flask or tube thus carefully prepared would grow turbid and show signs of life. On examination it was then found that some tiny crack in the closed end of the flask had admitted the external air and with it the germs of life. To this it was objected that by the successive heatings and coolings the liquid had been rendered incapable of originating life. If shown that such a tube or flask on being opened speedily swarmed with microbia, the abiogenists replied that the free admission of air had restored the necessary qualities to the liquid. It is often said that if abiogenesis were possible life would surely sometimes originate in the many thousands of tins of mutton, beef, fish, fruits, and vegetables which are now important articles of commerce. Dr. Bastian replies that a rarefied atmosphere is conducive to spontaneous generation, whilst that inside a "tin" is condensed. Dr. Tyndall proves that this view is erroneous. If a "tin" is opened under water, the water rushes in to fill up the partial vacuum. Dr. Bastian's contention thus damages his own cause.

But Prof. Tyndall's most decisive experiment is based upon the fact that air if kept at perfect rest for a few days deposits all its suspended matter, organic or inorganic, the spores or germs of microbia included. Liquids boiled with proper precautions and exposed to such air remain barren. It is impossible to describe this apparatus without the aid of the accompanying cuts. The experiment appears to us, however, most satisfactory, and we do not see what valid reply can be made by the upholders of spontaneous generation.

It must be remembered that neither the experiments of Pouchet and Bastian, nor of Pasteur and Tyndall, have any direct bearing upon the first appearance of life upon our globe. All four have operated with organic matter only, which in the azoic ages was *ex hypothesi* absent. Dr. Tyndall may, however, urge that if organic matter will not give spontaneous rise to life, neither, *a fortiori*, will inorganic bodies.

Modification of Ruhmkorff's Coil.—MM. Scarpa and Baldo.—With an induced coil, arranged in two blocks placed on the poles of the magnetic nucleus and communicating with each other, so that their points of junction may be at equal distances from the nucleus, effects are obtained of much greater power than with the ordinary arrangement.—*Les Mondes.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 8, August 22, 1881.

Existence of a New Metallic Element, Actinium, in the Zinc of Commerce.—Dr. T. L. Phipson.—The author gives the substance in question the name of Actinium, on account of the curious actinic phenomenon which he has described in two communications (CHEMICAL NEWS, vol. xliii., p. 283, and vol. xliv., p. 73). The phenomenon appears due to the presence of a new metallic element, Actinium. The sulphide of this metal is white, but becomes brown, and finally black, under the reductive action of the sun's rays; a plate of glass hinders this blackening. In darkness the white colour is restored by oxidation. The new metal differs from indium and gallium in not being precipitable by metallic zinc.

On a New Series of Phosphates and Arseniates.—MM. E. Filhol and Senderens.—In their researches on the quantities of heat liberated by the addition of successive quantities of soda to one equivalent of phosphoric acid, MM. Berthelot and Louguinine have observed that in order to obtain solutions neutral to coloured reagents it was necessary to use 1½ equivalents of soda to 1 equivalent of phosphoric acid. They do not seem to have examined if the solution neutral to litmus would give a definite crystalline phosphate. The authors have obtained this salt—sesquisodic phosphate. It may be regarded as formed by the combination of 1 mol. monosodium phosphate and 1 mol. disodium phosphate. They have also obtained an analogous arseniate.

Fixation of Hypochlorous Acid upon the Propargylic Compounds.—L. Henry.—The propargylic compounds (ethylic and methylic) combine readily with hypochlorous acid, even in very dilute solutions, forming a heavy oil.

Bulletin de la Société Chimique de Paris. No. 9, May 5, 1881.

Influence of Succinic Acid upon the Fermentation of Cane-Sugar.—U. Gayon.—Succinic acid alone is not capable of producing the inversion of cane-sugar.

Combinations of Phthalic Anhydride with the Hydrocarbons of the Benzol Series.—MM. Friedel and Crafts.—The desired reactions are easily effected on mixing about equal parts of the hydrocarbon, the anhydride, and of aluminium chloride, and heating them in the water-bath for two or three hours. The product of the reaction is poured into water by small portions, and boiled with a large excess of water. All the aluminium chloride and a part of the phthalic acid are thus removed. The acid obtained is dissolved in ammonia and precipitated by hydrochloric acid from the dilute boiling solution.

No. 10, May 20, 1881.

Evaporation-Heat of Sulphuric Anhydride.—M. Berthelot.—The evaporation of SO_3, at about 18°, absorbs 5·9 cals.

Formation-Heat of the Oxides of Sulphur.—M. Berthelot.—Already noticed.

Solubility of Tribasic Alkaline Phosphate in Ammoniacal Salts and in Neutral Alkaline Salts, from an Analytical and Agricultural Point of View.—A. Terreil.—The ammoniacal salts dissolve tricalcic phosphate in proportions varying from 0·309 per cent of the phosphoric acid present, in case of the nitrate, to 7·08 per cent in case of the citrate. Potassium citrate dissolves from 2·02 to 1·78 per cent.

Sterilisation of the most Unstable Animal and Vegetable Liquids in the Cold.—P. Miquel and L. Benoist.—This process will be inserted at length.

Russian Chemical Society.—Session, November 6/18, 1880.—M. A. Krakau.

M. Lubavine described the action of ammonium cyanide upon various anhydrides.

M. Markownikow described the preparation and the properties of itaconic anhydride, and conjointly with M. Krestownikow he made a communication concerning a new acid, the homo-itaconic.

M. Miller announced that, contrary to the statement of Toumsky, phenol-phthaleine may serve as an indicator in alkalimetry.

M. Jagn submitted an apparatus for the automatic washing of precipitates.

M. Zagoumenny gave a full description of the formation and the properties of benzo-pinacone, benzo-pinacoline, tri-phenyl-methan, and tetra-phenyl-ethan.

MM. Maltchewsky and Sokoloff announce that the action of iodine upon sodium bisulphite gives rise to sodium dithionate.

M. Golubeff, on causing nitric acid to react upon desoxybenzoin, has obtained a third isomeric dinitro derivative in yellow crystalline needles melting at 154° to 155°.

M. Bronnikoff described a method for the determination of ammonia and nitric acid by colorimetric procedures.

M. Driguine described a double hydrochlorate of quinine and urea.

M. Boungue gave a communication on the electrolysis of the formic and mellic acids, and remarks on the nature of a gelatinous matter deposited in the manufacture of beet-root sugar.

M. Tanatar sent in a memoir on the structure of the fumaric and maleic acids.

MM. Danilewski and Radenhausen gave an account of researches on the albumenoids of cows' milk, and on the decomposition-products of the albumenoids.

M. Potilitzine described the double decomposition of salts in aqueous solution from a thermo-chemical point of view.

M. Louguinine gave an account of his researches on the combustion-heats of certain alcohols of the allyl series.

MISCELLANEOUS.

London Hospital Medical College.—The eighth Biennial Festival of this College was held on Monday evening, at the "Criterion." Dr. Robert Barnes presided, and was well supported by a large number of members of the Staff and former pupils of the Hospital. The usual loyal toasts having been drunk, Dr. Barnes, in proposing our "Alma Mater," alluded to the great clinical opportunities afforded at the Hospital, and to the increasing prosperity of the School, which has of late been considerably enlarged and improved. Dr. Barnes also made a feeling allusion to the deaths of Dr. Billing and Mr. Luke, who were for very many years on the Staff of the Hospital. Mr. John Henry Buxton, the Chairman of the Hospital, Dr. Andrew Clark, and Mr. Hutchinson also spoke of the well-being of the School, and of the good feeling that existed between the House Committee and the Staff.

King's College, London.—Lessons in Metallurgy.—Under the direction of Prof. A. K. Huntington, the Laboratory for instruction in Metallurgy is open to Students every day from 10 to 4 (except on Saturday, when the College closes at 1); on Friday evenings from 7 to 9. Lectures will be delivered on Mondays and Thursdays at 4 p.m., and on Wednesdays at 7 p.m. Fees (including materials):—Day classes: Lectures only, £3 3s; Laboratory for one month, £6 6s.; two months, £11 11; three months, £15 15s; six months, £27 6s.; nine months, £37 16s. Students attending the Laboratory can attend the Lectures without further charge. Students taking a month's ticket may attend daily during such time as the Laboratory is open, or three days a week for two months, or two days a week for three months. Evening classes:

Lectures only, £1 11s. 6d.; Laboratory only, £2 2s. The course of Lectures is designed for all those who in any way have to do practically with the applications of metals. It treats of the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts. The following are the principal subjects treated of:—General considerations concerning the principles of Metallurgy. Physical properties of metals. The physical and chemical properties of various kinds of fuel; the selection and economic preparation of fuel to suit the requirements of special processes. Materials used in the construction of furnaces, &c.; fire-bricks, crucibles, &c. The various methods by which iron and steel are produced; the effects caused by the presence of foreign substances. Copper-smelting; alloys of copper, &c. Treatment of zinc ores; means by which it can be rolled into sheets; alloys of zinc, *e.g.*, brass, Muntz's metal, &c. Smeting and desilverisation of lead. Extraction of silver from its ores; its alloys. Methods of extraction of gold, and parting from silver and copper, &c. Smelting of tin ores. Tin-plating, bronze, &c. The means by which antimony, bismuth, nickel, cobalt, mercury, &c., are obtained; their properties and uses will also be discussed. Practical Metallurgy:—The work in the Laboratory is intended to illustrate the principles discussed in the Lectures. The instruction given to each Student is, however, regulated by his special requirements.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chloride of Calcium Process for Refining Sulphur.—Can any of your correspondents give me any information as to the chloride of calcium process for refining sulphur mentioned in a paragraph in the *Times* a few days ago, as having been devised by MM. de la Tour de Breuil? Any information on the point will be interesting.—Brimstone.

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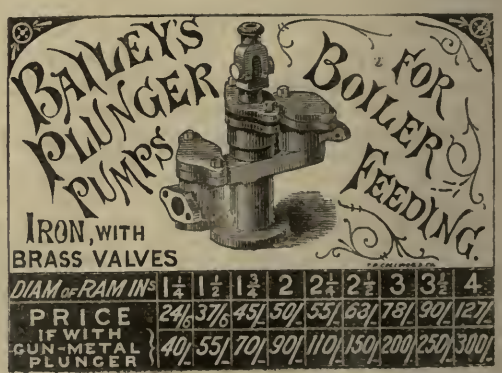
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THE CHEMICAL NEWS.

VOL. XLIV. No. 1142.

ON THE PHOTOGRAPHIC SPECTRUM OF COMET "*b*," 1881.*

By WILLIAM HUGGINS, D.L.C., LL.D, F.R.S.

IN the year 1866 and 1868 I applied the spectroscope to the light of comets, and in the latter year I showed that the three bright bands in the visible part of the spectrum agree with the similar bright bands which are seen when an induction spark is taken in olefiant gas.† The same bands are also seen in the flames of many compounds of carbon. I was inclined at that time to consider that these bands were due to the vapour of carbon. Subsequent investigations which have been made on the spectra of the compounds of carbon appear to make it probable that these bands are the spectrum of a compound of carbon with hydrogen. These observations (1868) showed the presence of carbon—probably in combination with hydrogen—in the cometary matter.

Since that time until the present year no comet has appeared sufficiently bright to allow of the observations on its spectrum being extended to the ultra-violet region. The apparatus with which I had successfully photographed the spectra of stars was especially suited to this purpose.‡ It consists essentially of a spectroscope, furnished with a prism of Iceland spar and bases of quartz, placed so that the slit shall be in the principal focus of a mirror eighteen inches in diameter, equatorially mounted, and driven by an electrically-controlled clock.

On the evening of June 24, 1881, I directed this instrument, armed with a very sensitive gelatin plate, to the head of Comet "*b*," so that the nucleus should be upon one-half of the slit. After an exposure of one hour the open half of the slit was closed, the shutter withdrawn from the other half, and the instrument was then directed to Arcturus for fifteen minutes.

After development the plate presented a very distinct spectrum of the comet, together with that of the star, for comparison.

The spectrum of the comet consists of two spectra superposed upon each other:—A continuous spectrum, which extends from about F to a little distance beyond H. In this continuous spectrum can be seen the Fraunhofer lines G, *h*, H, K, and many others. This spectrum is, therefore, due to reflected solar light. The second spectrum consists of two sets of bright lines and a suspicion of the presence of a third set. These lines are obviously to be referred to original light from the comet.

The strongest set consists of two bright lines in the commencement of the ultra-violet region. Measures, made by the aid of the comparison star-spectrum, give for these bright lines the wave-lengths 3883 and 3870. The less refrangible line is much stronger, and a faint luminosity can be traced from it to a little beyond the second line 3870. There can be, therefore, no doubt that these lines represent the brightest end of the ultra-violet group which appears under certain circumstances in the spectra of the compounds of carbon. Professors Liveing and Dewar have found for the strong line at the beginning of the group the wave-length 3882·7, and for the second line 3870·5.

I am also able to see upon the continuous solar spectrum a distinct, though fainter, impression of a group of lines between G and *h*. There can be little doubt that this group is the one for the least-refrangible limit of which the wave-length 4220 is given by Professors Liveing and Dewar.

An increase of brightness in the continuous spectrum is also seen between *h* and H, which may be due to other bright lines; but the photograph is not strong enough to admit of any certain conclusion on this point.

On June 25 a second photograph was obtained with an exposure of an hour and a-half. This photograph, notwithstanding the longer exposure, is fainter, but shows distinctly the bright lines in the ultra-violet and the continuous spectrum.

These photographs confirm the results of my earlier observations on comets—that part of their light is reflected sunlight, and part is original light; and, further, that carbon is present in the cometary matter.

The new bright groups in the comet's spectrum which the photographs have revealed to us are certainly characteristic of substances containing carbon.

In their paper "*On the Spectra of the Compounds of Carbon* (*Proc. Roy. Soc.*, vol. xx., p. 494)," Profs. Liveing and Dewar bring forward evidence to show that these two groups indicate the presence of cyanogen, and are not to be seen in hydrocarbons unless nitrogen is also present. If this be the case, the photograph supplies us with strong evidence of the presence of nitrogen in the comet, in addition to the carbon and hydrogen shown to be there by the bright groups in the visible region of the spectrum. It is of great interest in connection with this result, now that Schiaperlli has shown us the close relationship of meteors and comets, to mention the results of Professor Graham's experiments on the gases occluded from the meteoric iron of Lenarto (*Proc. Roy. Soc.*, vol. xv., p. 502, 1867). This iron gave nearly three times its volume of gas, consisting chiefly of hydrogen, with small quantities of carbonic oxide and nitrogen.

Professor Wright's examination of the stony meteorites shows the oxides of carbon, chiefly the dioxide, to be present in largest quantity; but he obtained also a small percentage of hydrogen and nitrogen (*Amer. Journ. Science*, vol. x., July, 1875).

Other kind of meteors are known which contain hydrocarbons, even in considerable quantity. It is scarcely necessary to add that, under suitable conditions, the spectra of the gases from meteorites will be similar to that observed from the light of comets.

Professors Liveing and Dewar's experiments would seem to show that a high temperature must be present in the comet if the cyanogen is formed there: but if cyanides should be found in meteorites the necessity would not exist.

Whatever the views that may be entertained as to the forms of combination in which the carbon exists, there can be no doubt whatever of the presence of carbon in comets. I should mention that Mr. Lockyer regards the two bright groups seen in the photograph, and the three groups in the visible spectrum, to be due to the vapour of carbon at different heat levels (*Proc. Roy. Soc.*, vol. xxx., 461).

It is of importance to mention the strong intensity in the photograph of the lines 3883 and 3870 as compared with the continuous spectrum, and the faint bright group beginning at 4220. At this part of the spectrum, therefore, the light emitted by the cometary matter exceeded by many times the reflected solar light.

On August 21 I attempted to obtain, with an exposure of one hour, a photograph of the spectrum of a large comet which has appeared since—Comet "*c*," 1881. The evening was not very favourable, and the comet was at a low altitude and not so brilliant as Comet "*b*." I am not able to see on the plate more than a faint trace of the brightest lines (W. C. 3883 and 3870) of the spectrum obtained from the former comet.

* Read before the British Association, York Meeting, Section B.
† *Phil. Trans.*, 1868, p. 556.
‡ *Phil. Trans.*, 1880, p. 669.

Saccharine.—E. Peligot, Prof. Descloiseaux, Dr. v. Lippmann, Prof. Scheibler.—Saccharine has the same percentage composition as cane-sugar, but differs it its properties. It is most readily obtained from lævulose lime. —*Biedermann's Centralblatt*, x., 1.

ON THE

SPECTRUM IMPRESSED ON SILVER CHLORIDE AND ITS BEARING ON SILVER PRINTING IN PHOTOGRAPHY.*

By Capt. W. DE W. ABNEY, R.E., F.R.S.

SILVER chloride is the haloid salt of silver which is most employed in silver printing in photography; but, till quite recently, it has been difficult to develop an image on it except by means of acid development. Even then it is necessary to give a very prolonged exposure, masking much that could be learnt regarding the rays to which it is sensitive, which is not the case when a short exposure can be given to it, and a stronger method of development. When silver chloride is formed as an emulsion in gelatin, plates may be prepared which Dr. Eder and Capt. Pizzighelli have shown can be developed with a neutral organic iron compound, viz., a solution of ferrous citrate in citrate of ammonia, or, as I have shown, by a stronger developer, viz., dissolving ferrous oxalate in a solution of potassium citrate. Dr. Eder has shown that hydrokinone—a developer which I brought to notice a year ago—could also be employed by rendering it alkaline with ammonium carbonate. In my recent investigations all these developers have been employed.

Gelatin plates were prepared containing silver chloride in its ordinary molecular state, as precipitated by a cold solution, and also others with the chloride modified in molecular structure by the aid of heat or by the application of ammonia. These were exposed to the spectrum, and on developing the three kinds of plates no very marked variation in the region to which the silver chloride is sensitive was observable. The place of maximum intensity at the least refrangible part of the spectrum was found to be at H,—that is, at the limit of the visible spectrum,—and the curve of sensitiveness seemed to follow the curve of energy in the ultra violet.

The absorption spectra of the chlorides were next photographed, and in the case of the cold-precipitated chloride a very faint canary-coloured tint was observed, and in the spectrum obtained there was total absorption beyond H, rapidly diminishing towards *h*, and fading off about F. From the modified chloride the slight absorption did not appear to reach beyond F, but started abruptly near H.

It will thus be seen that the absorption spectrum answered to the spectrum impressed on the silver chloride; that is, that where the radiations were absorbed work was done in the molecules of the silver chloride.

My next experiment was to expose to the spectrum silver chloride spread on paper, to which a slight wash of potassium nitrate was given in order to absorb the chlorine evolved by the action of light, which the gelatin did in the first experiments. By careful observation it was found that the maximum intensity, as shown by visible colouration, was situated at the same locality, viz, H, spreading to G, and below; in fact the two spectra, viz., the developed and the printed, agreed perfectly together.

When ordinary sensitised albumenised paper was exposed to the printing action of the spectrum, the H lines and the G lines appeared apparently simultaneously, but there was a marked difference in the colour of the two portions. That part near H was much bluer than near G. Where the spectrum was allowed to fall on pure albuminate of silver the maximum effect was found near G, and G was found to be impressed before H. Now, in albumenised paper we have two factors. We have the albuminate of silver and also the silver chloride, both of which are formed when the albumenised paper of commerce is floated on the silver nitrate bath. We have therefore a ready explanation of the behaviour of the albumenised paper when placed in the spectrum, and the difference in colour about G and H. About H the chloride, and at G the albuminate, of silver give their colour to the print.

There is a practical appreciation of this research in ordinary photographic printing. In the winter time it is well known that silver prints on albumenised paper lack the brilliancy of tone which can be secured in the summer or spring, and that in dull weather the same want is felt. In the winter time the light is deficient in the ultra violet rays, and consequently more proportionate work is done by the albuminate than by the chloride of silver. In other words, the image is more composed of the former than of the latter.

I may point out a remarkable confirmation of this result in position of maximum sensitiveness in the spectrum impressed on silver chloride, as found by Dr. Eder. He found the maximum in the blue, and that for taking negatives the silver chloride had only one-twentieth the rapidity of silver bromide in the same medium. My own experiments were made in July, and the sensitiveness of the chloride for negative work was but little inferior to that of silver bromide, whilst my maximum was found at H. The extra proportion of ultra violet rays evidently gave the increase in apparent sensitiveness, and also the shifting of the least refrangible maximum. I am not aware what prisms Dr. Eder used. If he employed those so often found in Germany, which have a yellowish tint, there would be a sound reason why he found the maximum in the blue. In my own case a diffraction grating with quartz lenses were used, or else very white medium-dense flint-glass prisms. Be this as it may, I have no hesitation in placing the maximum at H. It should be remarked that for the comparison of all silver salts a standard light should be used, and the most convenient that I have found is the crater of the positive pole of the electric light, an image of which is projected on the slit. Since this has always the same temperature, the same proportion of rays are emitted.

The examination thus made also points to the necessary care that must be taken in suiting the quantity of silver chloride to albumen for different states of light in silver printing,—or, at all events, to the length of time of sensitising albumenised paper,—so as to obtain a right proportion of the organic and haloid salts. Into this question I need not enter, since I have treated of it elsewhere. The remarks I then made were based on long-continued practice in silver printing, being unaware, when they were written, as to the theoretical reason for the course to be pursued.

It is a very common idea that the rays which can affect silver chloride, or indeed any other silver haloid, are dependent on the medium in which it is placed. I would point out that this is not the case, so far as regards the haloid. If the medium absorb the rays which can affect the haloid, then we may look for an alteration in effect, and not otherwise. The molecules will always answer to the same undæ if these undæ can have access to them.

It is in the knowledge of photographers that the different colour of the deposit of silver in a negative largely modifies the tone of the print and its capacity for giving brilliant prints. The explanation will be found in what I have brought forward. Thus, in my hands, prints from negatives which are stained of a yellow or brown colour—such as are many gelatin negatives—can never secure that brilliancy of tone that a negative which is colourless can give. There is also an olive-green colour to the deposit of silver in some negatives, which, though very thin to all appearance, gives excellent prints. This particular colour in very moderate thickness cuts off all the ultra violet rays; hence its efficiency. The black deposit of silver which is particularly noticeable in negatives developed by ferrous oxalate cuts off all rays nearly equally; hence the greater facility of judging the right intensity of a negative when this means of development is adopted. My advice to photographers is that at all hazards they should get rid of the brown stain which is so apparent in many gelatin negatives, if they wish to secure the greatest brilliancy in their prints from such negatives.

One more bearing this subject has, viz., on the scientific measurement of the radiation of total daylight by means

* Read before the British Association, York Meeting, Section B.

of silver chloride. Up to the present time I have always been under the impression that we have, by means of Roscoe's actinometer, been measuring all the rays as far as G in their totality. I think it will be seen that we are measuring less than that. For my own part, I would say that I am glad of it; for the more we can isolate any particular parts of the spectrum for measurement the better it is for the value of those measurements. Perhaps by using twin instruments—one fed with silver chloride paper and another with silver bromide—we may get still further advantages than we are already reaping from the continuous observations we are making at South Kensington.

I would here wish to add that Mr. H. Darwin, with the advice of Prof. Roscoe, has now made a form of Roscoe instrument which works perfectly in every way; and I hope that Prof. Roscoe may next meeting be able to criticise the results obtained by our proposed trial of chloride and bromide, and tell us whether he thinks the suggestion now made is worth carrying on.

I need scarcely point out the importance of the methods introduced by Dr. Roscoe of obtaining a record of the effect of certain radiations of daylight; and it appears to me that we are now, by the aid of the new instrument, in a position to make more exhaustive records than has previously been the case.

NOTE ON A NEW METHOD OF MEASURING CERTAIN CHEMICAL AFFINITIES.*

By ALFRED TRIBE.

WHEN a metal is immersed in an electrolytic field (*i.e.*, in an electrolyte in the act of electrolysis), and the electromotive force set up on any part of its surface suffices to overcome the affinities of the radicles of the medium, the positive ion separates on that part of the surface which may be supposed to have received −electrification, and the negative ion on that part which receives +electrification.

When the metal is in the form of a rectangular plate, and placed so that the lines of force are perpendicular to its surface, the maximum electromotive force set up is on the central parts of such a plate, becoming less towards the edges, where, and for some little distance from which, it is insufficient to initiate electro-chemical action.

When the rectangular plate is placed in the electrolytic field, so that the lines of force are parallel with one of its edges, the maximum electromotive force is on the end of the plate, becoming less and less towards the central parts until it no longer suffices to bring about electro-chemical action. This is denoted by the boundaries of the deposit, which in many cases are very sharply defined. A plate, in fact, in the position just named, may be regarded, in so far as electrical power is concerned, as a series of pairs of electrodes, the limit of the electro-deposits representing a pair, the electromotive force of which is just incapable of resolving the electrolyte into its constituent ions (*Proc. Roy. Soc.*, Nos. 209, 214, 1881; *Phil. Mag.*, p. 446, 1881).

The very intimate relation between electromotive force and chemical affinity was a long time ago pointed out by Sir W. Thomson, and recently in an elaborate research by Dr. Wright. It was therefore anticipated that if, in a series of trials, the chemical affinities were altered while other circumstances remained the same, the magnitude of the intermedial space between the boundaries of the electro-deposits would increase along with the force required to overcome the affinities of the ions of the electrolyte.

A series of experiments with molecular solutions of the chloride, bromide, and iodide of zinc with plates (*analysers*) of silver, copper, iron, and zinc, showed that this is the case; *i.e.*, the intermedial space with the chloride was greatest, the bromide less, and the iodide least. Another series with silver analysers, but with molecular solutions of the sulphates of zinc and copper, showed that the intermedial space in the case of the zinc sulphate was much the greater. Again, another series with zinc sulphate showed that a zinc analyser gave the least intermedial space, iron greater, copper greater still, and silver most of all.

This method affords a simple means of demonstrating differences of chemical affinity, but whether it is capable of giving more than approximate measurements will require further investigation to determine. In some cases secondary actions are, of course, set up, so that the intermedial space would represent the initial electromotive force + or − any interfering electromotive forces.

Dulwich College, August, 1881.

* Read before the British Association, York Meeting, Section B.

CELLULOSE AND COAL.*

By E. J. BEVAN and C. F. CROSS.

IN prosecuting our researches into the constitution of the jute fibre, we subjected it to the action of sulphuric acid, with the object of converting the carbohydrate constituents into dextrin and the aromatic constituents, which we have shown to belong to the tannin group, into the condensation-products characteristic of this group, and thus of effecting their more accurate separation. The fibre was dissolved by the acid at ordinary temperatures to a viscous solution; on diluting a flocculent precipitate of the aromatic bodies was formed, but on washing it passed into solution in proportion as the acid was washed away. On heating the viscous solution to from 60° to 70° for some minutes a copious separation of a black substance took place, and on adding water and filtering we obtained a colourless filtrate from which the whole of the fibre substance appeared to have been removed. This black substance was converted by the action of chlorine into a substitution compound of bright yellow colour, completely soluble in alcohol, and containing, therefore, no free carbon. To the formation of the black substance the cellulose of the fibre had evidently contributed, and we therefore for obvious reasons turned our attention to the action of the acid upon this substance. Taking an acid, of sp. gr. 1·6, and heating the viscous solution of the cellulose (dextrin) to from 70° to 80°, the colour changed from yellow to dark brown; copious effervescence then ensued, and accompanied by the formation of a considerable quantity of acetic acid, a black spongey substance separated out, which was instantly drenched with water. On washing and drying at 100° it passed into a form exactly resembling an ordinary coal; and the resemblance did not end here, the composition proving to be similar as regards C, H, and O, as was also its behaviour on heating. We append analyses of preparations of this body:—

From dextrin	0·2505 gave	0·0935 H_2O and	0·5845 CO_2
,, ,,	0·254 ,,	0·097 ,, ,,	0·594 ,,
From jute	0·159 ,,	0·064 ,, ,,	0·374 ,,

C	63·6	63·7	64·4
H	4·14	4·24	4·4
O	32·26	32·06	31·2
	100·00	100·00	100·0

If the acid be more concentrated, or the mass be rapidly heated, more highly carbonaceous products are obtained, having, moreover, a much denser structure. One of these bodies was found to contain 68·5 per cent C and 4·04 per cent H.†

* Read before the British Association, York Meeting, Section B.

† Compare lignite containing 68 per cent C and 5·8 per cent H (Vaux).

The spongy products are easily converted by the action of a current of chlorine gas at ordinary temperatures in presence of water into orange-coloured substitution derivatives, exactly resembling those obtained by the direct chlorination of lignified fibres, *i.e.*, smelling of tetra-chloroquinon, soluble in alkalies to deep red-brown solutions, which are much deepened in colour by previous treatment with sodium sulphite. The denser products are also convertible into these derivatives, but they require the action of $KClO_3$ and HCl (dil.) at 70°. We append the analysis of one of these derivatives obtained by the latter method and carefully purified.

0·4655 gave 0·464 AgCl and 0·013 Ag
0·2476 ,, 0·3955 CO_2 ,, 0·0625 H_2O
0·3000 ,, 0·4915 ,, ,, 0·075

			Calc. $C_{20}H_{16}Cl_4O_{10}$
C ..	43·56	43·6	43·01
H ..	2·82	2·76	2·86
Cl ..		25·58	25·4

Comparing this body with those obtained by us from jute, $C_{19}H_{18}Cl_4O_9$, and esparto, $C_{22}H_{23}Cl_4O_{10}$ (*Journ. Chem. Soc.*, 38, 666), the resemblance is seen to extend to composition. Having, therefore, through the medium of the action of sulphuric acid, passed from carbohydrated to bodies of aromatic structure, identical, moreover, with those directly obtainable from lignified fibres, are we justified in assuming that any such conversion takes place, in the living plants, of cellulose into lignin?

In the first place, working to this hypothesis, we found that the reaction of dextrin with sulphuric acid is very destructive in character. Three determinations of the yield of the (spongey) black substance gave the following percentages: 35·1, 34·8, 34·3. Allowing for the higher percentage of carbon in the product, these members correspond to about 50 per cent of the original carbon, *i.e.*, one half the carbon has been eliminated as carbonic and acetic acids, &c. Without further evidence, therefore, it cannot be inferred that there is anything in the reaction more than a passage from one great group of carbon compounds to another.

On the other hand, in fibres which tend to lignification the percentage of cellulose is always inverse to that of lignin; and the microscopic investigation of the process of lignification has led to the conclusion that it is the result of an intrinsic modification of the substance of the cell wall (cellulose), and not to the infiltrating of substances from the cavity of the cell.

In jute there is evidence of the existence of a constituent intermediate between these two groups—a body which by special treatment may be converted into cellulose, but in the ordinary processes of estimating cellulose is degraded by oxidation into bodies of the humus group. Thus, in our method of estimating cellulose, if the chlorination of the fibre is followed by some hours' contact with sulphurous acid, previously to the alkaline treatment, the result is an increase in the yield of cellulose to the extent of 2 to 5 per cent. An investigation of the formation of hippuric acid in the process of digestion (herbivorous) led to the conclusion by Meissner and Shepard ("Die Hippursäure," Hannover, 1866) of the presence of a particular constituent in ordinary fodder (hay), containing a benzoic residue, the withdrawal of which causes the disappearance of the acid from the urine; this constituent they regard *as a particular form of cellulose*. Our own investigation of hay led to the identification therein of the aromatic constituents characteristic of bast fibres; and we have, therefore, in the above conclusion, a further probability of the conversion of cellulose into aromatic bodies as the result of plant life, and therefore of the existence of intermediate products. We have previously (*loc. cit.*) spoken of a peculiar degradation of the jute fibre, the result of a species of fermentation which takes place when masses of the fibre are allowed to lie in the damp state. The most noticeable features of this decomposition are the destruction of cellulose (20 to 30 per cent) and the formation of a soluble astringent, aromatic substance, belonging to the tannin group. When these facts are considered in connection with the homogeneity of the jute fibre,* and with the fact that although *resolvable* into cellulose and aromatic bodies, the association of its constituents in the natural fibre is of the most intimate character, the conclusion of a close structural connection is almost inevitable. The whole chemistry of the astringent substances, their almost invariable association with carbohydrates, their evident formation at the expense of the constituents of normal plant structures (pathological tannins), and the long held but recently controverted view of tannic acid as being a *glucoside* of gallic acid, shows the intimate connection in nature of these bodies with the carbohydrates.

We have now to say a few words on the subject of coal, to a consideration of which our experiments obviously lead. It is sufficiently expressive of the comparative looseness of views upon this subject to find that the authors of our most modern handbook do not hesitate to speak of coal "*as a form of carbon* less pure than wood charcoal."† Balzer has recently given expression to the more reasonable hypothesis that it is made up of a series of compounds of C, O, N, and H, genetically if not homologously related. We have found that a cannel coal when treated with chlorine in presence of water is converted into substitution-products of a brown colour, which when treated with potash swell up like starch and are then dissolved to a deep brown solution, without residue. On neutralising with an acid a copious flocculent precipitate is obtained which shrinks enormously on drying, and ultimately yields a black jet-like substance of high lustre. The same coal reacts also vigorously with bromine and with nitric acid, being likewise converted into soluble products. As, however, the carbon hypothesis of the composition of coal has never held any place as a substantive theory, it scarcely needed to be dislodged by experiment. These facts, however, and the formation of similar coal-like bodies from cellulose by the action of sulphuric acid, make it at least probable that cellulose, lignin, peat, lignite, cannel coal, and anthracite, are terms of a vast series of compounds, differentiated under natural conditions difficult of elucidation and impossible to reproduce.

* Compare also Erdmann's researches on glycodrupose (*Ann. Chem Pharm.* 138, 1), which we find closely similar in composition.
† *Vierteljschr. Zurch. Naturf. Ges.*, Jg. xvii., 1.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING SEPTEMBER 30TH, 1881.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

October 3rd, 1881.

SIR,—We beg to lay before you the results of our daily examinations of the water delivered, for the month ending the 30th of September, by the seven London water companies taking their supply from the Thames and the Lea. The samples are taken by a man in our service at places and times which we ourselves appoint.

In 12 only of the 182 samples taken during the month were we able to detect by examining the water in large bulk

with the naked eye the minutest trace of matter in suspension. The turbidity in six of these samples occurred in the supply of the East London Company.

In Table I. we have recorded the analyses in detail of samples, one taken daily from September 1st to September 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter we have described in a previous report.

Of the 26 samples supplied by the New River Company, the whole, without exception, were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, six were recorded as "very slightly turbid," the remainder being well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, all (excepting one) were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole, excepting one sample which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole excepting two which were "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was noted as "very slightly turbid." The rest were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

Altogether, the water supplied by the Companies during the month of September continues to be of excellent quality, though no longer presenting that exceptional freedom from other than blue colour, by which it was characterised during the summer months.

We remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

SOME DOUBLE AND TRIPLE OXALATES CONTAINING CHROMIUM.

By F. W. CLARKE.

CHROMIC oxalate unites with other oxalates to form two well-known series of double salts. One series is represented by the blue potassio-chromic oxalate, $Cr_2K_6C_{12}O_{24}6H_2O$. The other is typified by the red salt, $Cr_2K_2C_8O_{16}8H_2O$. The compounds described in this paper belong to the higher series.

The barium, strontium, and calcium salts of this series were discovered by Rees-Reece.* By mixing solutions of the ammonium salt with the chlorides of barium, strontium, and calcium, he obtained precipitates of dark violet silky needles, having the following formulæ:—

1. $Cr_2Ba_3C_{12}O_{24}.12H_2O$.
2. $Cr_2Ba_3C_{12}O_{24}.18H_2O$.
3. $Cr_2Sr_3C_{12}O_{24}.18H_2O$.
4. $Cr_2Ca_3C_{12}O_{24}.36H_2O$.

By a different process, Berlin† prepared a calcium salt with 18 aq., a lead salt with 15 aq., and a silver salt with 9 aq.; besides other compounds which need no mention here.

About a year ago, I requested Mr. E. A. Kebler to reprepare the barium salts described by Rees-Reece. The only variation from the method of the latter chemist was in using the potassium salt instead of the ammonium salt for the precipitant. Masses of very dark green silky needles were thrown down, and these were easily re-crystallisable from boiling water. Two hydrates of the desired salt were thus obtained, one agreeing with the twelve molecule salt of Rees-Reece, while the other, lighter coloured, contained but seven molecules of water. For the latter, the subjoined analytical data were found:—

	Found.	Theory.
Cr	8·94	8·90
Ba	34·96	35·16
H_2O	10·91	10·77

The formation of this new hydrate naturally led to experiments aimed at the discovery of the conditions under which different degrees of hydration were produced. Although this point was not definitely settled, interesting results were secured. Four samples of the double oxalate were precipitated, two from dilute and two from concentrated solutions. Two were thrown down in the cold, and two were precipitated boiling. All the precipitates were in the form of green silky needles, which were carefully air dried. In these several preparations the following percentages of water were obtained:—

						Mean.
Precip. concent'd, cold	9·50	9·78	9·19			9·49
Precip. concent'd, hot	9·39	9·31				9·35
Precip. dilute, cold	9·98	9·90	9·43	10·10	10·72	10·03
Precip. dilute, hot	12·07	12·13	11·12			11·77

Theory for 6 molecules of water	9·38
" " 7 " "	10·77
" " 8 " "	12·13

It will be seen that the two salts precipitated from concentrated solutions are definitely hexhydrated; the third salt gave doubtful results; while the last agrees fairly with the percentage for eight molecules of water. Evidently the six molecule salt is definite and typical; doubtless the twelve and eighteen molecule salts of Rees-Reece are definite also; all the other hydrates may be but mixtures of the lowest with one of the higher compounds. This point remains to be settled. The colour is always darker, the higher the hydration; but, though green under ordinary circumstances, all the salts described in this paper become dull violet by gaslight. Specific gravities were found as follows:—

$Cr_2Ba_3C_{12}O_{24}$	Anhydrous	2·570 at 6·8°
"	$6H_2O$.	2·445 at 13·9°
"	$12H_2O$.	2·372 at 27°

Here the second salt is nearly a mean between the other two.

The strontium salts were also prepared by Mr. Kebler, under varying conditions of temperature and dilution. These too came down as pale green satiny needles of considerable beauty, and easily re-crystallisable from hot water. From cold dilute solutions the salt $Cr_2Sr_3C_{12}O_{24}.12H_2O$ was precipitated.

	Found.	Theory.
Cr	9·36	9·37
Sr	23·59	23·64
H_2O	19·29	19·45

From the mother-liquor and washings of this salt a somewhat lower hydrate was deposited, possibly a mixture, corresponding in hydration to $10\frac{1}{2}$ molecules of

* *Comptes Rendus*, xxi., 1116.
† *Berzelius' Jahresbericht*, xxiv., 244.

water. Specific gravity 2·148 at 8·8°. From hot concentrated solutions of the precipitants a deca-hydrated salt was obtained. Calling these salts A and B respectively, we have the following analytical data:—

	Found.		Theory 10½ aq.	Theory 10 aq.
	A.	B.	A.	B.
Cr ..	9·55	9·52	9·59	9·67
Sr ..	24·14	24·31	24·22	24·45
H_2O..	17·36	16·87	17·40	16·75

I am inclined to look upon these preparations as mixtures of the twelve molecule salt with small quantities of a hexhydrated salt yet to be discovered.

The mother-liquors from all these strontium precipitates were united and concentrated. Upon standing, a very dark green, almost black, crystalline crust was deposited. This, which had a specific gravity of 2·155 at 12·8°, proved to be a new triple oxalate having the formula—

$$Cr_2Sr_2K_2C_{12}O_{24},$$

with either eleven or twelve molecules of water.

	Found.	Theory, 11 aq.	Theory, 12 aq.
Cr	9·51	9·60	9·44
Sr	16·15	16·15	15·89
K	7·26	7·22	7·10
H_2O ..	18·33	18·28	19·61

I suspect that the twelve molecule formula is the true one, and that the salt as analysed by Mr. Kebler may have been slightly effloresced. Still, the analytical agreement with the lower formula is wonderfully close.

The discovery of this new triple salt led to a search for the corresponding barium compound. The ordinary bario-chromic oxalate was accordingly dissolved with an equivalent quantity of the potassium salt in boiling water, and the mixture was then heated with barium carbonate in order to remove a little free oxalic acid which happened to be present as an impurity. Upon filtering, dull bluish green needles were deposited, having the composition $Cr_2Ba_2K_2C_{12}O_{24}$, with five or six molecules of water.

	Found.	Theory, 5 aq.	Theory, 6 aq.
Cr	9·86	9·68	9·53
Ba	24·25	25·51	25·09
K	7·41	7·28	7·14
H_2O ..	8·65	8·38	9·89

Since the salts which yield this triple salt each contained six molecules of water, I am inclined to consider that as the true degree of hydration for the compound now in question. In fact, throughout this series of complex oxalates, the hydration is almost uniformly six molecular, or represented by some even mutiple of six. The chief exceptions are the lead and silver salts of Berlin, with 15 aq. and 9 aq. respectively; values which are regular submultiples of six.

The process by which these barium and strontium salts are prepared from the potassium salt is suggestive of their constitution. We may fairly regard the chromic oxalate itself as a weak acid, having the subjoined structural formula:—

$$\left.\begin{matrix}H.C_2O_4\\H.C_2O_4\\H.C_2O_4\end{matrix}\right\}Cr—Cr\left\{\begin{matrix}C_2O_4.H.\\C_2O_4.H.\\C_2O_4.H.\end{matrix}\right.$$

These six atoms of hydrogen are replaceable by six potassium atoms, by three barium atoms, or by two of each, and so on with all the other salts of the series. If chromium be regarded as trivalent, the formulæ should of course be halved.

We attempted to prepare the sexbasic acid here suggested, but did not attain to final results. The barium salt was decomposed by an exactly equivalent quantity of sulphuric acid. Upon filtering, an acid liquid was obtained, strongly dichroic, and dark violet red by transmitted light. Probably this was the acid in question, but actual proof is yet wanting.

Mr. Kebler also tried to prepare several other salts of the series under discussion, but unsuccessfully. No calcium salt like that of Rees-Reece could be obtained. Calcium oxalate, slightly discoloured by chromium, was thrown down every time. With salts of cadmium, cobalt, ferrous iron, zinc, copper, lead, and stannous tin, the blue potassio-chromic oxalate gives either no precipitate, or else, after some time, a precipitate of the ordinary oxalates of the metals in question. The filtrates from these oxalates afterwards deposit crystals, too impure for analysis, which appear to be the potassio-chromic salt of the red series. The plan of heating bario-chromic oxalate with the sulphates of cadmium, cobalt, copper, iron, and zinc was also tried. In each case an ordinary oxalate was formed, mixed with barium sulphate.—*American Chemical Journal.*

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. X.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(64.) *On Iod-ammonium Iodide, the Product of the Action of Dry Gaseous Ammonia upon Iodine.* By W. H. Seamon, of Wheeling, West Virginia.

In 1814 Colin* examined the action of dry ammonia gas upon dry iodine, and observed the production of a viscid liquid, which had a somewhat metallic lustre, was non-explosive, and took up an excess of ammonia, forming a less viscid, very dark red-brown liquid, also without explosive character, the union of the two substances being attended with rise of temperature, but no evolution of gas. He considered that simple "protiodure" and "deutiodure d'ammoniaque" had been formed, but gave no quantitative results.

In 1838 Bineau† exposed a known amount of iodine in a recurved gas jar to the action of gaseous ammonia, and determined the volume absorbed of the latter. Reducing volume to weight, he found in two experiments that 100 parts of iodine took up 20·7 and 20·4 parts respectively of ammonia. Hence he deduced the formula $N_3H_9I_2$, and suggested that either the compound is simply an "iodide of ammonia," as imagined by Colin, or may be viewed as containing nitrogen iodide, and represented as—

$$3(NH_3.HI)+NI_3+5NH_3, \text{ or as}$$
$$3\left\{(NH_3)_2.HI\right\}+(NH_3)_2.NI_3.$$

In the same year Millon‡ published the results of his experiments upon the second (more fluid) of the compounds produced by Colin, which alone he considered to be definite in character, the viscid liquid containing in addition variable amounts of free iodine. Millon found that at +10° C. 100 parts of iodine absorbed 8·3 parts of ammonia, when the tube was surrounded by snow the gain of weight was 9·0 parts, and when surrounded by a mixture of snow and salt 9·4 parts. He stated that it was impossible to produce complete saturation, since after a time a continuous current of ammonia carried off some of the product, and accurate weighing of the residue was prevented. He concluded that the substance actually produced contained I_3 for $(NH_3)_2$, but may be represented by the formula $3(NH_3.HI)+(NH_3)_2.NI_3$, with an excess of iodine due to incomplete saturation, this formula

* *Annales de Chimie*, 91, 262.
† *Annales de Chimie et de Physique* (II.), 67, 226.
‡ *Annales de Chimie et de Physique* (II.), 69, 84.

agreeing with his supposed production of the same substance by the action of ammonium iodide on so-called iodide of nitrogen containing hydrogen.

Mr. Seamon made a number of experiments with a view to ascertaining precisely what compound or compounds can be produced by the absorption at various temperatures of dry gaseous ammonia by pure solid iodine. The results were indefinite and unsatisfactory until the following plan was adopted. The ammonia was expelled by heat from its aqueous solution, and dried by passage through a cool empty bulb, a U-shaped tube of lime, and finally two tubes of solid potassium hydrate, making together 1 metre in length. The iodine was placed in a long-necked flask, fitted with two tubes, one, reaching nearly to the bottom, serving to introduce the gas, while the other carried off such of it as was not absorbed. The flask was immersed in a bath of melting ice crushed to small fragments. The flow of gas was kept up as long as any was absorbed. The greater part of the liquid product from the bottom of the flask was then transferred to a previously weighed, dry, wide-mouthed, glass stoppered, little bottle, which was at once placed (without the stopper) inside a jar admitting of being tightly closed, the same jar also containing a second open, wide-mouthed bottle of concentrated sulphuric acid. The jar was closed, surrounded by melting ice, and allowed to stand for ten days, with renewal of the ice as it melted. The acid kept the interior of the jar dry and absorbed all surplus ammonia, of which a considerable quantity was given off by the iodine compound. At the end of this time, it having been ascertained by occasionally inserting the stopper in the weighing bottle and determining its weight that no further loss of ammonia would take place, the bottle was removed, and its weight accurately taken. The contents were washed out with a solution of sodium sulphite, and in separate portions of the liquid the iodine was determined as silver iodide, and the ammonia by distillation with sodium hydrate, absorption in standard sulphuric acid, and titration with standard soda.

The results of analysis were definite and consistent. In one experiment, in which about 12 grms. of the iodine compound had been formed, Mr. Seamon obtained—

		Calc. for NH_3I_3.
I	93·745	93·702
NH_3	6·190	6·298
	99·935	100·000

It is obvious, therefore, that the compound in question, prepared under these definite conditions, is identical with the iod-ammonium iodide, which may be written—

$$N\left\{\begin{matrix}H_3\\I\end{matrix}\right\}I,$$

prepared by Guthrie* by treating a saturated solution of very soluble ammonium salt (nitrate or carbonate) with about one-third of an equivalent of potassium hydrate, and adding finely powdered iodine in small portions, avoiding excess.

The general properties of the material agree with Guthrie's description. It is in mass a black, lustrous liquid, in thin layers of dark red-brown colour by transmitted light. Sp. gr. = 2·46 at about 15° C. Solidifies at −8° C. to a reddish black solid, which melts again at −2°. Is slowly decomposed by keeping at a temperature a little above 15°; more rapidly, without boiling, at 70°. It is readily soluble in glacial acetic acid, anhydrous glycerin, absolute alcohol, and dry ether: less soluble in benzene and carbon disulphide.

No definite substance could be obtained correspoding to the formula of either Millon or Bineau.

(65.) *On an Interesting Specimen of Native Gold from Montgomery Co., Virginia.* By SAMUEL PORCHER, of Hanover Court-House, Virginia.

The specimen in question represents the product of gold-washing, which has for the last year or two been carried on with some profit in Montgomery Co., in this State. The metal is in small rounded grains, which have almost exactly the colour of fine gold and full metallic lustre; but the specific gravity is low (15·46), and on cutting the grains, or scraping them with a knife, it becomes apparent that the colour first observed is superficial only, the metal in the interior being almost white. Mr. Porcher's analysis gave—

Gold (by cupellation and parting)	65·31
Silver (by cupellation and difference) ..	34·01
Copper	0·14
Iron	0·20
Quartz	0·34
	100·00

The atomic ratio of gold to silver is 100·0 : 94·9. Hence, allowing for the partial removal of silver which the surface has experienced, this alloy seems in all probability to consist of single atoms of the two precious metals, or may be represented as AgAu. The like proportion is recorded for a native gold from Transylvania, and one from Santa Rosa, New Grenada, both analysed by Boussingault,* and one from Schlangenberg, in the Altai, analysed by Klaproth.†

(66.) *On the Temperatures at which Mercuric Oxide is formed, by Direct Union of its Elements, and Decomposed, respectively.* By W. H. ECHOLS, jun., of Huntsville, Alabama.

It was known as early as the days of Geber that metallic mercury moderately heated in the air becomes converted into a red solid substance, and that a stronger heat prevents this or reproduces the metal with its original properties, and these changes have acquired historic importance as furnishing the means to Lavoisier for the analysis of air. No statement is, however, on record, so far as I am aware, as to the exact points of temperature at which the two opposite changes occur, most of the text-books merely saying that the metal heated to about its boiling-point is converted into mercuric oxide, and that this oxide at something like a red heat is resolved again into mercury and oxygen.

Mr. Echols made some experiments on the temperature required for the two changes in question, using Carnelly's method‡ of comparison with the fusing-points of various salts heated under similar conditions. A piece of hard glass combustion tubing, open at both ends, was bent to an obtuse angle in the middle; pure mercury was placed in the bend, which was immersed in a bath of melted lead, heated by a large gas burner. A very slow stream of dry oxygen was passed through the tube. A precisely similar tube placed beside this contained at the bend a small quantity of each of the comparison salts taken separately in succession. The temperature was very gradually raised. The red oxide began to be formed at a temperature between the fusing-points of—

ZnI_2..	446° C. (Carnelly) and
AgCl	451 ,, ,,

The red mercuric oxide (crystalline) was then placed in the bent tube, and the temperature gradually raised until the first faint deposit of metallic mercury was seen to form on the cool part of the glass. This occurred between the fusing-points of—

NaI	628° C. (Carnelly) and
KI	634 ,, ,,

The experiments were repeated with dry air passing through the tube instead of oxygen. No difference was observable, except that the temperature at which the oxide was formed seemed to be if anything a little nearer

* *Chem. Soc. Jour.*, July, 1863, 239.

* *Annales de Chimie et de Physique*, 24, 408.
† *Beiträger*, iv., 1.
‡ *Chem. Soc. Jour.*, July, 1878, 273.

the melting-point of the silver chloride than that of the zinc iodide.

Hence it may be stated that mercuric oxide is first formed by direct union of mercury and oxygen at about 450° C., and that mercuric oxide begins to be decomposed at about 630°. All the experiments were made under ordinary atmospheric pressure, about 740 to 745 m.m.

(67.) *On the Production of Hydrated Crystals of Barium Nitrate in Isomorphous Admixture with Strontium Nitrate.* By R. A. Berry, of Marion, South Carolina.

It is remarkable, in view of the isomorphous relations of barium and strontium salts, that no hydrated nitrate of barium has been obtained with composition analogous to that of the strontium salt, $Sr(NO_3)_2.4H_2O$. Indeed, the only substance in which water of crystallisation is reported as taken up by the salt of the former metal is that of an experiment by Hirzel,* in which a solution cooled to between 12° and 0° is said to have once yielded a product containing *two* molecules of water.

Mr. Berry made numerous attempts to obtain hydrated crystals of barium nitrate by evaporation of the solution under various conditions of temperature and rate of evaporation, including an air-pump vacuum over sulphuric acid in a receiver surrounded by ice, but in every case the common octahedral anhydrous crystals were alone obtained.

He then attempted to crystallise a mixed solution of the nitrates of barium and strontium at such low temperatures as would lead to the formation of hydrated crystals of the latter; but these were found to be free from barium, and the barium nitrate separated out in anhydrous octahedra.

At last, however, it was found that by saturating the same portion of water with both nitrates, introducing a well-formed crystal of hydrated strontium nitrate to serve as a nucleus, and evaporating *in vacuo* over sulphuric acid at a temperature kept close to 0° C., crystals identical in form with the nucleus could be grown, and these on analysis proved to contain the two nitrates in amorphous admixture. The water was determined by careful heating below the temperature of decomposition of either nitrate; the barium was separated as chromate by the method of Frerichs,† with attention to the suggestions in the paper by Morse‡—the method being also tested by comparative experiments here, and found to give satisfactory results—and the strontium was found by difference. Two analyses of different specimens, using in each case large *single* crystals only, gave§—

I.

		Atomic Ratios.	
$Ba(NO_3)_2$..	17·50	0·0672	0·3391—1
$Sr(NO_3)_2$ ..	57·37	0·2719	
H_2O	25·13		1·3961—4·12
	100·00		

II.

$Ba(NO_3)_2$..	10·75	0·0412	0·3421—1
$Sr(NO_3)_2$ ..	63·48	0·3009	
H_2O	25·77		1·4317—4·19
	100·00		

(To be continued.)

Decomposition of Mercury and Silver Cyanide.—E. J. Maumené.—From the behaviour of the brown residue left after the decomposition of mercury cyanide by heat the author assigns to para-cyanogen the formula $(C_2N)_4$. *Bulletin de la Société Chimique de Paris.*

* *Zeitschrift für Pharmacie*, 1854, 49.
† *Berichte der Deut. Chem. Gesellschaft*, 1874, 800, 956.
‡ *Amer. Chem. Jour.*, June, 1880, 176.
§ Not quite free from flaws or little internal cavities, hence doubtless the small excess of water.

NOTICES OF BOOKS.

A Report on the Teaching of Chemistry and Physics in the United States. By Frank Wigglesworth Clarke, S.B., Professor of Chemistry and Physics in the University of Cincinnati. Washington: Government Printing Office. 1881.

This report gives a very complete account of the manner in which chemistry and physics are taught in the United States. It is compiled principally from the answers given by the various professors and schoolmasters to certain questions asked. These questions, sent out by the Commissioner of Education towards the close of the year 1878, were very comprehensive, covering the ground from the most elementary work of the common schools up to the highest courses of the Universities. The history of instruction in chemistry and physics, the present courses of study, the text-books used, the value of apparatus, the laboratory facilities, the character of examinations, and the cultivation of original research, were all made subjects of enquiry.

Gradually answers came in: some questions were answered fully, others vaguely. One set of answers has been left almost entirely out of consideration, namely, those relative to examinations: they were full enough in many cases, but resting on no common basis they could not be fairly compared.

The object of the report is twofold—first, to state the facts; secondly, to point out the defects and remedies. The bulk of the work is occupied by text descriptive of single institutions, and by statistics of a general character.

The teachers are divided in opinion as to whether book work and laboratory practice should be carried on at the same time. The writer of this report holds strongly (and we think with good reason) to the opinion that both should go on together.

The comparison of the work done in chemistry and physics at schools and colleges is very interesting. In most cases the latter teach chemistry and physics to the same extent, and in the same manner as the former. It is obvious that the colleges ought to do higher work than the schools; the present duplication of studies is clearly a waste of time. In some few cases this rule is not followed, higher work being done than in the schools.

The chapter giving an historical sketch of the growth of chemistry in America is very interesting. Fifty years ago no college would have given chemistry an equal rank with Greek, but now choice is permitted between the two subjects in many institutions.

The University of Pennsylvania Medical School in 1768, the Medical School of Harvard College in 1782, and the Dartmouth School in 1798, are among the places where chemical science was first taught. Between 1800 and 1845 the study of science grew slowly but surely into favour; here and there at home professors opened laboratories for the use of the more scientifically-inclined students. One thing, however, was wanting, namely, the recognition of the importance of original research.

Among reports from over one hundred and seventy cities only a few show that there is *no* scientific training. In some schools the pupils begin laboratory work at a very early age. The following letter, written by a teacher in New York to the Commissioner of Education, will show what can be done for the advancement of scientific knowledge:—

"Dear Sir,—Twenty years ago I was in the habit of having a teacher lecture on chemistry and physics in my school. I asked him what he would charge to sit still and not touch anything, but give directions and advice while a small class of boys handled what was necessary and made their own experiments. He said, 'They will break things.' I said, 'Yes, you must take that into account.' After thinking about it he said, 'I should have to charge five dollars an hour.' This was rather

dear, but I concluded to try it. The first trial convinced me that I was on the right track. They were soon taught to handle acids, to bend glass tubes, as well as to make hydrogen and oxygen; and I saw small boys in my own school learn more of useful chemistry in three months than I learned in three years in college. Towards the close of the school year one of the boys came to me and asked for one of my visiting cards. On asking what for, I was told that their teacher of chemistry had informed them that there was a metal used in enamelling the cards, and they were directed to find it out. They did so. Two years ago I had in my school my son of nine years. On asking my teacher of chemistry whether he thought so young a boy could learn chemistry in this way, he said 'Certainly.' Joining two others of that age with him, I was quite surprised at the end of two weeks to see them making their own hydrogen and oxygen, and performing for themselves experiments that I used to look at with wonder when done by others while I was in college. I have pursued this practical system of teaching ever since, and always with success. My only difficulty has been to persuade parents to allow their children to be taught in this way. I have taken the liberty of writing to you at length about this matter, because it seems to me very important, and perhaps some one else may be encouraged to pursue the same course. I have been amazed at the general apathy displayed about these studies, and am delighted at your trying to arouse the public to a proper sense of their importance."

Many schoolmasters think that chemistry and physics cannot be taught practically without a quantity of expensive apparatus, but this is a mistake. A country school teacher was awarded a special prize at the Paris Exhibition for a set of apparatus made by himself out of the commonest materials (glass bottles and the like).

In the chapter on institutions for the superior instruction of women we read the following:—"One of the questions sent out in the circular issued by the Bureau of Education, preparatory to this report, was as follows.—'Are pupils permitted to do extra laboratory work?' To this the President of one of the female Colleges answers, 'Being girls, no.' This answer typifies a widespread sentiment and a common misapprehension as to the object of scientific teaching. It may represent the assumption that girls are in some mysterious way unfit to undertake laboratory practice, or the belief that such instruction would be useless to them. Neither view is correct, as the experience of many teachers of science can testify."

In the chapter on Universities, Colleges, and Schools of Science, a single rule is followed. With few exceptions, only those institutions are described in which laboratory work is done by students and carried as far as a course in qualitative analysis. The other colleges are duly treated of in the statistical tables.

There are about one hundred and twenty pages describing the various methods of teaching science in the Colleges and Universities, and then a list of text-books used. From the tables of statistics at the end we gather that, taking it all in all, chemistry and physics are very well taught in the United States. There are numbers of institutions which are well known and looked upon as first class colleges, while in England the number of such places is very few.

CORRESPONDENCE.

ACTINIUM.

To the Editor of the Chemical News.

Sir,—My experiments on the new metal Actinium have been interrupted in various ways, and by the fact that, for the sake of my health, I have been compelled to leave London for a short time. The metal has been isolated by means of magnesium, which precipitates it rapidly from its ammoniacal solution, with evolution of abundance of hydrogen and considerable production of heat. Zinc does not precipitate it either in the neutral, ammoniacal, or slightly acid solutions, either cold or hot. Precipitated by magnesium it forms a light grey deposit, which, by compression, becomes white like silver and extremely brilliant; it oxidises slowly in ordinary water and saline solutions, but can be preserved under alcohol. As the only method which I have yet discovered of separating oxide of actinium from oxide of zinc is by means of caustic soda, I am not certain that I have, hitherto, obtained the process perfectly exempt from oxide of zinc, even after four or five treatments at boiling heat. Hence, I hesitate for the present to describe its reactions and salts. However, I may state that the sulphate crystallises in magnificent modified octahedra. The sulphide in the state of hydrate oxidises somewhat by contact with the air, and in this state possesses the property of displacing ferrous oxide from the sulphate of iron. The action of light upon the partially oxidised sulphide is more rapid in contact with a little pyrogallic acid, ferrous sulphate, or yellow sulphide of ammonium. I hope to be able to continue these experiments in a few weeks.—I am, &c.,

T. L. Phipson.

Southsea, October 7, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 9, August 29, 1881.

Dioptric Studies.—Ch. V. Zenger.—A mathematical paper, not capable of useful abridgment.

Certain New Cases of Equipotential Figures realised Electro-chemically.—A. Guébhard.—This memoir does not admit of abstraction.

Absorption of the Ultra-violet Rays by Certain Media.—M. de Chardonnet.—The juices of vegetables all appear greedy of the chemical rays. The sap of the vine in spring is very active, as are also tincture of arnica, and white and red wine, even when very dilute. Fluorescence does not seem to be in direct relation with the intensity of actinic absorption. With animal fluids the results are more varied. Blood, even much diluted, is an energetic absorbent. The aqueous humour of the eye and the white of a hen's egg have no action upon the chemical rays. Distilled water, alcohol, ether, collodion, and solution of cane-sugar are without action.

Figures Produced by the Fall of a Drop of Water holding Red-Lead in Suspension.—C. Decharme.—Regular figures have been obtained formed of red-lead arranged in rays and concentric rings.

Composition of Buck-Wheat.—G. Lechartier.—The proportion of mineral matter in the straw increases along with its weight. The straw may, indeed, become richer in phosphoric acid than the grain, differing thus completely from that of the cereals. The straw of a crop of buck-wheat may contain much more mineral matter than does the grain. The sum of the principal fertilisers removed from the soil by an entire crop is much more considerable than for a crop of wheat containing the same quantity of grain.

Hydrosulphurous Acid.—Aug. Bernthsen.—A reply to the papers of M. Schützenberger (*Comptes Rendus*, xcii., p. 875, and xciii., pp. 47 and 151).

Solution of Silver in Presence of Alkaline Iodides.—A. Ditte.—If a plate of silver is placed in a solution of

potassium iodide containing 5 per cent, and the whole is left exposed to the air, the metal becomes covered with brilliant crystals of silver iodide. The action is quickest at the surface where the access of the air is free. In very concentrated solutions there is no formation of crystals, as the silver iodide dissolves in the potassium iodide.

Constitution of Glyceric Ether and Transformation of Epichlorhydrin into Normal Propylic Alcohol.—R. D. Silva.—The author having prepared allylic alcohol by the method of Tollens and Henninger slightly modified, obtained the glyceric ether of Gegerfelt, the etheric character of which has not been established by any decided reaction.

Pyruvic Alcohol and its Derivatives.—L. Henry.—Dipropargyl yields, by double decomposition, hexylic diacetyl.

Action of Tri-ethyl-amin upon Epichlor-hydrin. Compounds of Oxallyl-tri-ethyl-ammonium.—E. Reboul.—Epichlor-hydrin and tri-ethyl-amin, if mixed in equal volumes, act upon each other below 100°, yielding ultimately oxallyl-tri-ethyl-ammonium chloride.

Observations on a New Enunciation of Gay-Lussac's Second Law on the Combinations of Gases.—M. Garcia de la Cruz.—M. Verschaffel (*Comptes Rendus*, xcii., p. 476) announced the following proposition:—The space occupied by a gaseous compound is always double the space occupied by that one of its components which enters into the compound with a smaller volume. This law comprises the rules of contraction in the cases where the volumes are equal or are in the ratio of 1 : 2. The author points out some of the numerous exceptions, such as phosphamin, arsenamin, ethylene bichloride, phosphorus trichloride, arsenious anhydride. The theoretic density of many substances in the gaseous state, as deduced from their formulæ, does not agree with the law announced, *e.g.*, nitrous, nitric, and chlorous anhydrides.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., No. 1.

The Proportion of Carbonic Acid in the Atmosphere.—An abstract from the *Comptes Rendus*, the *Chem. Central-Blatt*, and the *Proceedings of the Royal Society*.

Determination of Rainfall.—M. Chrimes and F. E. Nipher.—The authors have measured the rainfall at different heights. They observed the same decrease of quantity in the 4 feet between 1 and 5 feet above the surface of the ground as in the 15 feet between 5 and 20. They find the decrease greater in exposed than in sheltered places, and ascribe it to the action of the wind.

Clover-Sickness of the Soil.—Dr. S. Linde.—As in the case of turnip-sickness this affection of the soil is due not to the exhaustion of certain constituents of the soil, but to the increase of animal and vegetable parasites. Hence a change of crop is more useful than manuring.

African Guano.—Dr. A. Petermann.—The guano in question is imported from the South African islands, Halifax, Pomona, Possession, and Ichaboe, and contains a total of 13·77 per cent nitrogen, and 8·8 per cent phosphoric acid. It is consequently superior to Peruvian guano as a source of nitrogen.

Phosphorites of Southern France.—L. L'Hote.—From the *Comptes Rendus*.

Manuring with Potassium Salts.—Adolf Mayer.—The author observes that the ashes of plants are uniformly basic; that fruitful arable soils present to the crops a suitable mixture of mineral food, but that by the copious use of mineral manures, and especially of Stassfurt salts, the proportions of this mixture are modified. Arable soils have a slightly alkaline, nearly neutral reaction, and only in such a medium can the roots of plants retain their health. All mineral manures may be arranged in three groups—the physiologically neutral, where acid and base are absorbed by the plant simultaneously; the physiologically basic, where the acid is absorbed more readily than the base; and the physiologically acid, where the base is assimilated more readily than the acid. The third class are in comparison with their amount of nutritive matter bad manures. They include the chlorides of ammonium, potassium, and magnesium, the sulphates of magnesia and potassa, the Stassfurt salts in general, and potash superphosphate. He recommends the addition of lime to Stassfurt salts, and a compost of peat-earth with potassium chloride and quicklime.

Comparative Experiments on the Action of Soluble, Reverted, and Precipitated Phosphoric Acid in Light Sandy Soils.—Dr. C. Müller and W. C. Müller-Scheessel.—Soluble phosphoric acid gave a better result than phosphoric acid soluble in ammonium citrate. The reverted acid had a decided influence on the yield, and a partial substitution of the latter for soluble acid had a remarkably favourable action.

Composition of Protoplasm.—Dr. Rodewald and Prof. J. Reinke.—The authors were able to obtain protoplasm in a state of purity from the fructification of *Æthalium septicum*, a fungus developed in heaps of tan. In its more solid portions the authors have identified the following bodies:—Vitelline, myosine, pepton, peptonoid, pepsin, nucleine, lecithine, guanine, sarkine, xanthine, ammonium carbonate, para-cholesterine, cholesterine, æthalium resin, a yellow pigment, glycoses, sugar (non-reductive), oleic, stearic, palmitic, butyric, carbonic acid, glycerides, and para-cholesterides of the fatty acids, calcium stearate, palmitate, oleate, lactate, oxalate, acetate, formiate, phosphate, carbonate, sulphate, magnesium and potassium phosphate, sodium chloride, and iron in an unknown state of combination. The albumenoids scarcely form 30 per cent of the entire weight.

The Injurious Action of Potato-Sugar.—Prof. Kedzie, Nessler, Barth, Fleck, and Schmitz.—Potato-sugar contains impurities of sulphuric acid, iron sulphate, and lime. Its most dangerous ingredient is a bitter matter remaining after the sugar has passed into fermentation, and which occasions cold sweats, oppression on the chest, headache, &c. Wines "gallised" with potato-sugar are consequently *pro tanto* poisonous, and the use of such sugars in brewing becomes a matter of questionable permissibility.

Examination of American Preserved Meats.—Prof. A. Mayer.—The author shows the presence in the cans of lead derived from the solder.

Influence of the Addition of Ammonia in Determining Bibasic Calcium Phosphate according to Petermann's Process.—Dr. A. König.—The author shows experimentally that the large addition of ammonia to the solution of citrate, as recommended by Petermann, is not justified, and causes the result to fall too low.

Vol. x., No. 2.

Relations between the Distribution of Atmospheric Pressure and the Distribution of the Rainfall.—J. Hann.—From observations made at more than 260 stations in Austria-Hungary, Switzerland, and Saxony, the author concludes that a relation between variation of the barometer and the rainfall cannot be shown; the fall of the barometer does not depend mainly on the rainfall, and is not notably affected by the latter. He mentions that the extremely violent rains of August 15 to 18, 1874, actually fell within the scope of a barometer maximum.

Humoid Matters Extracted from the Soil of Alkalies.—Dr. Otto Pitsch.—In most soils, phosphoric acid, if present in the form of iron or aluminium phosphate, is soluble in ammonium humate. The author considers that humus is of great importance for arable soils, not merely by improving their physical condition, but by its chemical action on the soil and its influence on the absorptive power of the latter.

Irrigation with the Drainage of Dunghills.—Prof. A. Müller.—The sandy soil operated collected little of the ingredients of the drainage, with the exception, perhaps, of phosphoric acid.

Application of Potassium Salts in Agriculture.—Prof. M. Maercker.—The failures on record in the use of potassium salts are often due to the fact that artificial manurial matters are sometimes applied without the simultaneous use of nitrogenous and phosphatic bodies. It is not to be expected that potassium salts can act advantageously on all soils and in all methods of cultivation, by the direct efficacy of their potash. As all potassium salts are converted in the soil into silicates, it is indifferent in case of a deficiency of potash whether it is supplied as sulphate or chloride. Potatoes, beetroot, and tobacco form exceptions, and are injuriously affected by potassium chloride. The magnesium chloride present in crude Stassfurt salts is, in dilute solutions, not more hurtful than equivalent quantities of potassium or sodium chloride.

Influence of Light upon the Transformation of Matter in Animals.—J. Moleschott, S. Fubini, and C Speck.—Moleschott and Fubini conclude that the elimination of carbonic acid increases under the influence of light, and that light acts not merely through the eyes, but upon the whole surface.

Researches on Splenic Fever.—L. Pasteur.—From the *Comptes Rendus*.

Scheibler's Process for the Determination of Sugar in Beets.—Prof. B. Tollens.—The author concludes that the results of this process approximate very closely to the truth.

Influence of Oxygen upon Fermentation.—A. Mayer, H. Hayduck, and M. Delbrück.—A. Mayer infers from his experiments that organic salts, such as potassium sodium tartrate, have a decided influence in promoting fermentation.

Archives Neerlandaises des Sciences Exactes et Naturelles. Tome xvi., Livraison 1me.

The Equations of the Movement of Gases, and the Propagation of Sound according to the Kinetic Theory of Gases.—H. A. Lorentz.—A mathematical paper, not susceptible of useful abridgment.

Crystallisation of the Diamond.—E. H. von Baumhauer.—A comparative crystallographic examination of the true diamond, of bort, and of supposed amorphous carbon. The difference is merely one of more or less perfect crystallisation, the three forms passing into each other by insensible gradations.

Tome xvi., Livraison 2me.

The Products of the Action of Phosphorus Pentachloride upon Acroleine.—P. van Ramburgh.—In this very elaborate paper the author takes as his point of departure certain researches of Hübner and Geuther (*Ann. Chem. Pharm.*, cxiv., 36). He examines acroleine chloride, the product boiling at 110°; the action of chlorine upon acroleine chloride, and upon the product boiling at 110°; the preparation of Hartenstein's tetrachloride, which boils not at 171°, but at 180°; the action of bromine upon acroleine chloride, and upon β-chlorated allyl chloride; and, finally, the accessory products boiling at higher temperatures.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Tome viii., No. 90.

This number contains no chemical memoirs.

Revue Universelle des Mines, de la Metallurgie, &c., No. 3, May and June, 1891.

This issue contains no chemical matter.

MISCELLANEOUS.

University College Chemical and Physical Society.—At a public meeting to be held on Friday, October 21, at 7 p.m., Prof. Alex. W. Williamson, Ph.D., LL.D., F.R.S., will deliver an address on "An Error in the Commonly Accepted Theory of Chemistry."

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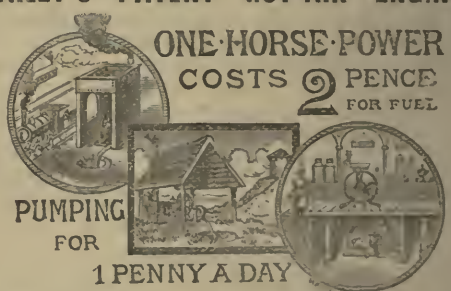

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THE CHEMICAL NEWS.

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AFFINITY AND VALENCY.

By FRED. D. BROWN.

Those chemists who were present at the recent meeting of the British Association must have been struck with the unanimity which prevailed in the Chemical Section with regard to that important property of the elements which we term valency or atomicity. Professors Williamson, Odling, Roscoe, and others, successively declared that it was impossible to attribute a constant combining power to the atoms, while it was more than once argued that if the idea of valency be retained in the science at all, it must be understood to refer to a property of the atoms which is subject to variations of unlimited extent.

This question has much occupied my attention during the present year, and I have gradually come to the conclusion that the force of affinity with which an atom tends to combine with another is unaltered, or but little altered, by such combination: in other words, if a force of attraction F be exerted between two atoms A and B, this force will remain the same whether A be combined with one or more atoms, C, D, &c., whether it be combined with a second atom A, or whether it lead for the time being an independent existence.

Many arguments in support of this hypothesis have from time to time occurred to me. Some of these are contained in a paper published in the October number of the *Philosophical Magazine*, but none, in my opinion, is more cogent than that derived from the very existence of chemical reactions. It is frequently said that the atoms forming the molecules of most chemical substances "have their affinities satisfied," and it is, I think, generally supposed that the chemical energy or affinity of the atoms is neutralised, such neutralisation being regarded as in some respects similar to that which takes place when a conductor charged with positive electricity is brought into contact with another which has received a negative charge. Yet, on reflection, it is evident that if this were the case it would not be possible for the molecule in question to exert any influence upon another, or, *a fortiori*, to enter into any chemical reaction. This argument will be better understood by applying it to some simple reaction, such, for example, as the formation of hydrochloric acid from hydrogen and chlorine, which we are accustomed to express by the equation—

$$H_2 + Cl_2 = 2HCl.$$

The molecule H_2 is supposed to be made up of two atoms of hydrogen united together by the force of chemical affinity in precisely the same manner as an atom of hydrogen is joined to an atom of chlorine in hydrochloric acid. Now, if neutralisation takes place at all between these two atoms it must be complete, for they are identical, and therefore neither of them can have a surplus of the attractive force available after the rest has been employed in neutralising that of the other; but if the neutralisation be complete, neither atom is in a position to combine with an atom of chlorine or to attract it in any way; hence the reaction cannot take place as long as the atoms of hydrogen are united together. That they remain thus united when left alone is proved by the fact that hydrogen gas obeys Avogadro's law. Since the reaction does take place we are bound to assume that in the molecule H_2 the affinity of the hydrogen atoms is not neutralised.

If we are forced to this conclusion in this particular case of hydrogen, we are equally so in the case of most other elements, but with compound bodies the argument is more complicated. Take, for instance, the case of water. We wish to show that the atoms of hydrogen and oxygen which form its molecule retain their original attractive forces when they are thus combined together. Now we can imagine (1) that the attractive forces are entirely neutralised; (2) that the hydrogen is only sufficient to neutralise a part of the affinity of the oxygen, leaving the rest free to act upon any other atom; (3) that the oxygen is only sufficient to neutralise a part of the affinity of the hydrogen atoms, leaving the rest free to act upon other atoms; (4) that the affinities are not neutralised at all.

We have already seen that the first supposition is inadmissible, since the molecule of water reacts upon other molecules. As regards the second view, that the attractive force of the hydrogen alone is entirely neutralised, it is discountenanced by the fact that chlorine acts upon the hydrogen of water, forming hydrochloric acid, and setting free the oxygen. It is true that this reaction is not one of everyday occurrence, but there is no doubt that under suitable conditions it really takes place. The third hypothesis, that the attraction of the oxygen is entirely neutralised, is disproved by numberless reactions in which the oxygen is attacked by atoms belonging to other molecules, while the hydrogen is liberated. We are, therefore, in this case also driven to the only other possible supposition, viz., that no neutralisation takes place.

It would not be difficult to apply the same line of reasoning to most other compound bodies, and thus to show that *in any molecule every atom retains the same affinity or power of attraction which it possesses when it is uncombined with any other.*

If this statement be true, it follows that as far as the force of affinity is concerned an atom may combine with any number of other atoms, or, in other words, that its valency must be unlimited. The number of atoms which can remain sufficiently close to it to be retained within the sphere of attraction is, however, necessarily very limited. Thus we may imagine an atom of nitrogen surrounded by a considerable number of atoms of hydrogen, each of which is moving with great velocity, and some few of these may come so close to the nitrogen as to be unable to get away again; but as soon as these hydrogen atoms, which remain constantly vibrating in the immediate neighbourhood of the nitrogen atom, have reached a certain number it will become impossible for any others to approach sufficiently near to be retained permanently. We may therefore reasonably ascribe the phenomena of valency to the conditions of space and motion under which the atoms are placed. By so doing, and admitting that the attractive forces exerted by the atoms remain unaltered, we are enabled to overcome most of the difficulties connected with the subject, and to account to ourselves in a fairly satisfactory manner for the variation of combining power and the existence of molecular compounds. Thus, with respect to the first point, it is clear that the valency of an atom must be dependent not only on the form, size, motion, &c., of the atom itself, but also on the same attributes of the atoms which tend to combine with it. The valency, therefore, might be expected to differ with the nature of these latter bodies.

With regard to substances such as NH_4Cl, H_2SiF_6, $BaCl_2 + 2H_2O$, which many are accustomed to regard as molecular compounds, the hypothesis that the affinity of the atoms is undiminished by combination renders it impossible to draw any distinction between them and the so-called atomic compounds of chemistry.

Solution of Chlorine in Water.—M. Berthelot.—At 12° one litre of pure water dissolves at the ordinary pressure 4 grms. of pure chlorine. In concentrated solutions of alkaline chlorides, chlorine is less soluble than in water, its solubility increasing with the dilution. In presence of hydrochloric acid chlorine dissolves more abundantly in water.—*Bull. de la Soc. Chim. de Paris.*

ON THE FORMATION OF SODIUM HYDRATE FROM THE SULPHATE.

By E. J. BEVAN and C. F. CROSS.

THE problem of the production of sodium hydrate from the sulphate is full of interest, both from its technical and theoretical bearings. As a possible method for the more economical preparation of alkali on the large scale, it has received the attention of several chemists, whose labours, however, being directed rather towards the result than the causes which determine it, have established little beyond the fact that the limit of conversion is so low as to be a veto upon its application as a manufacturing process. The object of our investigation was to test the accuracy of the statements which have been made concerning this limit, and to give a precise expression to the influence of its several factors.

Before proceeding to the statement of our results it will be necessary to glance briefly at the historical evidence on the subject. Of the earlier chemists, Delius, Achard, Scheele, Klaproth, and Westrumb, have treated of the preparation of alkali by this method. (Lunge's "Alkali," ii., 325). In 1840 Anthon showed the partial character of the decomposition; in 1852 it was made the subject of an English patent by Claussen, but proved economically a failure. In 1865 Hunter introduced the condition of excessive pressure. He employed solutions of sodium and of potassium sulphate of sp. gr. 1·1, and excess of lime, the pressure to which the solutions were subjected being 40 to 50 lbs. per square inch in the former and 80 to 90 lbs. in the latter case (*Jahresber.*, 1866, 846). This process likewise appears to have failed commercially. Hill investigated the reaction under various pressures, but the yield of hydrate proved in all cases very meagre (CHEMICAL NEWS, xxviii., 165). In reference to the reaction under the atmospheric pressure with lime and sodium sulphate he says—"In experiments upon this I never succeeded in getting 1 per cent of soda in the sulphate as caustic soda." Under a pressure of 3 atm the decomposition reached 6 per cent, and under 13 atm., continued for several hours, 13 per cent was converted into hydrate. As, however, it is not stated that the solutions were filtered under pressure, a precaution adopted by Hunter to obviate reverse decomposition, these numbers probably do not represent the maxima actually obtained. According to Tessié du Motay (*Berl. Ber.*, v. 741), 75 to 80 per cent of the sodium sulphate is causticised in twelve hours by lime, under the joint conditions of high pressure (2 to 20 atm.) and low temperature (0° to −20°), but we cannot find that these results have been realised on the large scale. More recently C. E. Davis has investigated the reaction, and kindly communicated his results to us. They are as follows:—

Sp. Gr. Solution.	Duration of Heating.	Pressure.	Decomposition p.ct.
1·03	24 hours	Atmospheric	1·8
1·02	12 ,,	5 lbs. per sq. in.	2·3
1·01	12 ,,	5 ,, ,, ,,	3·0
1·005	12 ,,	5 ,, ,, ,,	8·0
1·005	12 ,,	10 ,, ,, ,,	17·8
1·005	12 ,,	75 ,, ,, ,,	23·0

Still more recently Lunge has instituted experiments upon this same problem, and the publication of his results (*Dingl. Polyt. Jour.*, 238, 69) has taken place during the course of our investigation. The numbers arrived at are comprised in the following table, (A) being the results obtained by boiling under the ordinary atmospheric pressure in flasks attached to upright condensers, (B) by heating for ten to twelve hours in sealed glass tubes.

From this it appears that the evidence of previous researches is remarkably conflicting.

As the first step in our investigation it was necessary to clear up a few points in connection with the solubilities of the reagents. The saturated solution of calcium sulphate

Proportions by Weight. Na_2SO_4 : CaO : H_2O.	Amount of Decomposition.
(A.)	
* 1 : 1 : 15	6·55 per cent
1 : 1·1 : 30	9·64 ,,
1 : 1·1 : 90	20·93 ,,
1 : 1 : 90	19·88 ,,
1 : 1 : 180	28·82 ,,

Temperature.	Pressure.	Proportion. Na_2SO_4 : CaO : H_2O.			Amount of Decompstn.
(B.)					
130—140°	2—3 atm.	1	1	6	3·13
130—145	2—3·5	1	1	10	11·2
150—175	5—8·5	1	1	25	31·7
150	5	1	1	50	23·49
150	5	1	2	50	23·91
140—150	4—5	1	1·1	10	13·88

* See Table III.

(at 15°) is variously stated to contain from 1-250th to 1-500th its weight.*

The wide discrepancies between the results of the different observers must be accounted for by differences in the state of the salt operated upon. We made some observations on this point, using a preparation precipitated by sulphuric acid from a solution of the chloride and well washed. The quantity dissolved (anhydrous) at 9° C. we found in three instances to be 1 in 493, 1 in 498, and 1 in 500: we also found that the quantity was not increased by prolonged contact. In the case of calcium hydrate, on the other hand, we found that time is a very important factor of the result. Thus, in a solution filtered after one hour's contact, we found 1 part CaO in 628 of solution; and after twenty-four hours' contact, 1 part in 575. In another instance, 1 in 824, as against 1 in 598, after twenty-four hours' contact. A number of similar determinations established the constancy of this result, but at the same time showed the phenomenon to be in other respects extremely irregular. The solubility in a saturated solution of calcium sulphate was found to be the same as in pure water, and in the same way to vary with the duration of contact. The most probable explanation of the influence of time is that solution is preceded by further hydration of the di-hydrate, and that the variations in the quantity dissolved in a given time are caused by corresponding variations in fineness of division, and other conditions affecting hydration.

We next determined the influence of caustic soda upon the solubility of calcium hydrate, having the *a priori* ground for regarding it as a precipitant, afforded by the absence of lime in the commercial preparations of caustic soda.

We found, in effect, that after ten minutes' contact with a solution of 2·8 per cent (Na_2O) not a trace of CaO had been taken up. After one hour's contact a small quantity had been dissolved, and that practically, therefore, lime is insoluble in a 3 per cent solution of caustic soda. Not only so, but also that a solution prepared directly from sodium, with exclusion of carbonic acid, gave a precipitate with lime-water.

We append the results of a series of observations upon the solubility of lime in soda solution.†

* The following statements are given by Storer ("Dic. Sol.") respecting the solubility of calcium sulphate:—1 part in 450 of boiling and 1 in 500 cold saturated solution (Bergmann); 1 in 250 to 300 (Dumas); 1 in 500 hot or cold (Fourcroix); 1 in 380 cold (Poggiale), and a maximum, at 35° C., of 1 in 400, as against minima of 1 in 500 at 0° C. and the boiling-point. To test the accuracy of this statement conjointly with its probable influence on the decomposition under investigation, we carried out an experiment uniform with Series D, with a dilution of 350 c.c., and duration of one week, and obtained at the temperature of 35° a decomposition of 25·2 per cent, as against 35 per cent at the ordinary temperature.

† The precipitating action of caustic soda upon solutions of lime throws some light upon the formation, during the preparation of the former by the ordinary method, of a curious compound of the two hydrates which is not decomposed by washing.

Per cent Na_2O.	Eqt. Na_2SO_4 in 150 c.c.	Per cent CaO dissolved. After 3 hours. (a)	(b)	After 24 hours.
1·16	4 grms.	1 in 8772	1 in 8770	1 in 4000
0·87	3 ,,	1 8333	1 8330	1 3400
0·58	2 ,,	1 5000	1 5000	1 3000
0·23	0·8 ,,	1 1530	—	1 1240
0·12	0·4 ,,	1 1210	—	1 986
0·06	0·2 ,,	1 920	—	1 533

These numbers afford additional proof of the influence of time.

We now turn our attention to the more special subject of our investigation. Confining ourselves throughout to the relative weights required by the equation—

$$Na_2SO_4 + Ca(OH)_2 = 2NaOH + CaSO_4,$$

and using uniformly 5 grms. Na_2SO_4 and 2 grms. CaO, our first experiments were directed towards the question of the influence of the partial solubility of the calcium sulphate. That this is of first importance follows from the fact that general considerations based on the laws of energy give us no ground for assigning a limit to the decomposition; and that such a limit occurs in the case of the sulphate, but not with the carbonate, phosphate, or silicate of sodium, is therefore referable to differences in the solubilities of the resulting calcium salts.

A. *Effect of Varying the Solubility of the Calcium Sulphate by Addition of Alcohol.* (1) Time constant (one week). Temperature 13° to 16° C.*

Vol. of Solution.	Percentage Composition by Vol. Water.	Alcohol.	Per cent Na_2SO_4 Decomposed.
(a) 400	100	—	33·8
(b) 400	77·5	22·5	54·8
(c) 400	33	67	25·3
(d) 350	100	—	35·0
(e) 300	30	70	44·6
(f) 300	40	60	21·6
(g) 300	100	—	30·0
(h) 250	64	36	29·1
(k) 250	100	—	28·1
(l) 200	55	45	19·8
(m) 200	100	—	26·3

(In *c*, *f*, *h*, *l*, no Ca was present in the filtered solutions; in *b*, *e* traces were found dissolved.)

The influence of the addition of alcohol upon the yield of alkali is very marked; that the maximum occurs when the percentage of spirit is comparatively low is due to the fact that the solubilities of the original reagents are likewise affected.†

(2) Time constant (4 hours). Temperature 85° C. Volume kept constant by means of an upright condenser.

Volume of Solution.	Percentage Alcohol by Volume.	Per cent Na_2SO_4 Decomposed.
200	45	29·2
200	—	8·5

* The method employed for determining the quantity of alkali in solution was as follows:—The solutions were filtered through dry filters, and at the temperature of the experiment. An aliquot portion of the filtrate was treated with carbonic acid gas until any carbonate precipitated was re-dissolved: the solution was then boiled, filtered, and titrated. The error due to reverse decomposition of the calcium sulphate by the sodium carbonate we neglected for the reasons—(1) That the amount of the sulphate dissolved was always much less than that indicated by its solubility, and even in experiments where the quantity formed was insufficient to saturate the volume of water it was for the most part precipitated; (2) that our numbers have a relative rather than an absolute value; and (3) the alternative method of throwing out the sulphate by addition of alcohol involved an error due to the removal of sodium hydrate by the precipitate.

† From the following table of the solubility of sodium sulphate in dilute alcohol it will be seen that in three of the above experiments the original reagents were insoluble in the liquid employed:—

Sp. Gr. Solution.	Containing Alcohol Per cent.	Contains saturated at 15°.
1·00	0	25·6
0·976	10	14·3
0·952	20	5·6
0·939	40	1·3

B. *Effect of Varying the Solubility of the Lime by Addition of Sugar.* Time constant (4 hours). Temperature (100°) and volume constant (boiled in flasks attached to upright condensers).

Vol. of Water.	Sugar added.	P.ct. Na_2SO_4 decomp.
350 c.c.	5 grms.	20·0
350	0·0	11·42

C. *Effect of Increasing the Solubility of the Calcium Sulphate by Addition of Sodium Chloride.* Conditions, otherwise, as above.

		P.ct. Na_2SO_4 decomp.
350 c.c.	5 grms. NaCl.	7·10

In the above experiments we have arrived at a more exact knowledge of the influence of the solubilities of the reagents, which it is seen are very powerful in affecting the limit of the reaction.

The next category of conditions affecting the results are the duration of the experiment, together with the temperature and volume of the solution, and those which, to use the language of molecular science, affect the number of collisions of the reacting molecules.

D. *Effect of Dilution.* (α) Time, 7 days; temperature 13·16°; the solutions were placed in stoppered bottles and agitated from time to time. (β) Time, 4 hours; solutions boiled in flasks attached to upright condensers.

Volume of Solution.	Percentage Na_2SO_4 Decomposed. (α)	(β)
100 c.c.	12·0	6·25
150	24·5	7·73
200	26·3	8·51
250	28·0	9·7
300	30·3	10·1
* 350	35·0	11·4
400	33·8	10·8
450	33·12	—
500	31·8	10·3
600	30·2	9·98
700	20·1	9·6
800	20·1	—

The maximum decomposition took place, in each series, when the volume of the solution reached 350 c.c., *i.e.*, when the molecular ratio $Na_2SO_4 : H_2O = 1 : 550$.

E. *Effect of Time.*—(α) vol. constant (350 c.c.); boiled in flasks attached to upright condensers. (β) vol. constant (250 c.c.); temp. 13° to 16°, solutions placed in stoppered bottles and agitated from time to time.

(α) Time.	Na_2SO_4 Decomp.	(β) Time.	Na_2SO_4 Decomp.
4 hours	11·42	4 hours	12·9
20 ,,	10·8	40 ,,	23·5
35 ,,	19·6	7 days (1)	28·0
96 ,,	25·2	7 ,, (2)	28·7
7 days	25·3	14 ,,	28·8

The attainment of the maximum is therefore a work of considerable time, both at the ordinary and boiling temperatures.

F. *Effect of Rest or Motion of the Liquid.*—Volume constant (350 c.c.); temperature 13° to 16°; time 7 days; size and shape of containing vessel constant.

	Yield P.ct.	Special Condition of the Experiment.
(a)	34·8	Perfect rest.
(b)	35·0	Occasional agitation.
(c)	34·7	Constant agitation; the vessel was attached to the fly-wheel of an engine in constant motion.
(d)	34·5	As in (c), with addition of asbestos to secure the maximum distribution of insoluble substances.

The absence of difference is remarkable.

* At 35° C., but under otherwise identical conditions, the decomposition reached only 25·2 per cent of the theoretical.

G. *Effect of Height of Liquid Column.*—Volume 350 c.c ; temperature 13° to 16° ; time 7 days ; liquid at rest.

Height of Column.	Decomposition per cent.
4 inches	34·6
24 ,,	24·3

The effect of the remaining limiting condition, viz., the decomposition of calcium sulphate by sodium hydrate, has also been investigated. In our experiments on this point we employed cold solutions of the hydrate, free from carbonate, which were placed in contact with excess of calcium sulphate for a period of twenty-four hours. The subjoined table embodies the first series of results:—

H.

	Vol. of Solution.	C.c. NaOH Soln. taken.	Eqt. to Na_2SO_4.	C.c. NaOH recovered.
(*a*)	150	1	0·2	0·98
(*b*)	150	2	0·4	2·00
(*c*)	150	3	0·6	2·98
(*d*)	150	4	0·8	3·95
(*e*)	150	5	1·0	4·95

The last column gives the result of titrating the filtered solution. These numbers were controlled by determinations of Ca and SO_4 in aliquot portions. From 50 c.c. of (*a*) we obtained 0·0587 CaO and 0·2412 $BaSO_4$: these, when converted into their equivalents of $CaSO_4$, furnish identical numbers. From 50 c.c. of (*e*) we obtained 0·0763 CaO (eqt. 0·185 $CaSO_4$) and 0·3372 $BaSO_4$ (eqt. 0·196 $CaSO_4$), and therefore evidence of incipient decomposition.

Having fixed this point we continued the observations with stronger solutions of the hydrate.

	Vol. of Solution.	C.c. NaOH Solution.	Eqt. Na_2SO_4.	C.c. NaOH recovered. (*a*)	C.c. NaOH recovered. (*β*)
(*f*)	150	5	1 grm.	0 95	0·98
(*g*)	150	10	2 ,,	1·19	1·2
(*h*)	150	15	3 ,,	1·74	1·69
(*i*)	150	20	4 ,,	2·59	—
(*k*)	150	25	5 ,,	3·3	2·98

In series (*a*) we made determinations of the ratio CaO : SO_3 in solution.† 50 c.c. of (*f*) gave 0·0672 CaO (eqt. 0·163 $CaSO_4$) and 0·3187 $BaSO_4$ (eqt. 0·18 $CaSO_4$). Here, as before, we observe a slight disturbance of the equivalents indicating the commencement of decomposition.

50 c.c. of (*k*) yielded 0·0302 CaO and 0·6405 $BaSO_4$. Assuming the CaO to be present entirely as sulphate, the calculated quantity of Na_2SO_4 present is 1·6 grms., as against 1·7 observed by the alkalimetric test.

It will be seen from these observations that in none of the previous experiments at the ordinary temperature was sufficient caustic soda formed to reach the limiting strength, and no reverse decomposition could therefore have taken place.

In conclusion we would call attention to the more remarkable facts which have come to light in the course of our investigations: (1.) That, even employing the reagents in the theoretical ratio of single molecules, the limit of the decomposition is much higher than the numbers previously assigned. (2.) By the addition of alcohol, the limit has been raised to 55 per cent of the theoretical yield. (3.) The most important factors of the limit are time and the degree of insolubility of the calcium sulphate in the menstruum employed; of lesser influence are temperature and the solubilities of the original reagents; and the decomposition is comparatively independent of the *visible* rest or motion of the system. (4.) The occurrence of reverse decomposition has been obviated by the extent of dilution of our solutions, but is shown to be fatal to the economical realisation of the reaction on the large scale.

* It will be seen on reference to our determinations of the solubility of lime in solutions of caustic soda, that traces only could be dissolved in the experiments of this series, and therefore the loss of alkalimetric strength measures the decomposition which has taken place, without sensible error.

† The solutions were diluted to 250 c.c. before estimating.

THE HYDROMETALLURGY OF COPPER, AND ITS SEPARATION FROM THE PRECIOUS METALS.*

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WET processes for the extraction of copper from its ores have of late attracted much attention, especially in Europe, where the use of cupriferous iron pyrites as a source of sulphur prevails. These processes present an additional interest, when, as is often the case, the copper ores to be treated contain one or both of the precious metals, since the complete separation of these from copper, either in the dry or the moist way, is, as is well known, one of the difficult problems of metallurgy. The principal wet processes hitherto in use for the extraction of copper from its ores may be included under three classes:—

I. Those in which the copper in sulphuretted ores is rendered soluble in water by calcining them, after a preliminary roasting which removes the greater part of their sulphur, with a portion of common salt, by which the copper is converted into a chloride (Longmaid and Henderson) or with sulphate of soda by which sulphate of copper is formed (Monnier). Allied to these is the method by which a portion of the copper is got as soluble sulphate by roasting without addition, a process which is sometimes modified and rendered more complete by re-roasting the lixiviated residues with the addition of a portion of raw sulphuretted ore (Bankart).

II. Those methods in which free chlorhydric or sulphuric acid is used to dissolve the copper from oxidised or roasted ores. These, while simple and efficient, are too costly, except in certain localities where chlorhydric acid is a waste product. Related to them is the plan which consists in exposing the oxidised and moistened ores to the slow action of sulphurous acid mixed with air, by which a soluble sulphate of copper is formed. It has been proposed to decompose the solutions of sulphate or chloride of copper by sulpuretted hydrogen, thus separating the copper as sulphide, and using the liberated acid to dissolve fresh portions of oxidised copper. It is, however, the almost universal practice to throw down the copper from its solutions, however obtained, in the metallic state by the use of iron, either scrap-iron or iron-sponge, although in some instances milk of lime has been used as a precipitant, by which oxide of copper is produced.

III. The method in which a hot solution of ferrous chloride, with common salt, is used to chloridise the oxidised copper and convert it into a mixture of cupric and cuprous chlorides, which latter, though nearly insoluble in water, is dissolved by help of the chloride of sodium. From this solution the copper is precipitated by metallic iron, thereby reproducing the ferrous chloride, and regenerating the solvent, an advantage which this process possesses over any other which gives the copper in the metallic form. This, which is known as the Hunt and Douglass method, may, in many cases, be used with advantage for the treatment of low-grade copper ores, and, as the neutral solvent does not dissolve either arsenic or antimony, enables fine copper to be got directly from ores holding these impurities.†

When, however, it is applied to the treatment of copper ores containing silver, the use of the bath of ferrous chloride and chloride of sodium has, in common with the method of roasting with salt, the disadvantage that it converts the silver into a chloride which is soluble in a strong solution

* A paper read before the American Institute of Mining Engineers at the Meeting at Staunton, Va., June, 1881. From the *Engineering and Mining Journal*.

† The hydrous silicate of copper (chrysocolla) is, like the carbonates of copper, completely decomposed by a hot solution of ferrous chloride with common salt. An account of the application of this method to the treatment of a crystalline hydrous silicate of alumina, magnesia, and copper (which is essentially a copper-chlorite, and has been described by the writer as a new species under the name of venerite), will be found in the *Transactions of the American Institute of Mining Engineers*, vol. iv., p. 328.

of chloride of sodium and is then with difficulty separated from the chlorides of copper. The separation of silver and copper when dissolved together in the state of chlorides has greatly exercised the ingenuity of metallurgical chemists from its importance in connection with the treatment of Spanish and Portuguese pyrites, now so extensively used in Great Britain as a source of sulphur, where their consumption in 1877 amounted to 600,000 tons. These ores contain on an average about forty-nine per cent of sulphur and two or three per cent of copper, with a little silver, equal, according to Claudet, to from twenty to twenty-eight grms. to the ton of ore, and traces of gold. The residues after calcination still retain three or four per cent of sulphur and about four per cent of copper, with sixty per cent or more of iron, chiefly as peroxide. This material, after having been again calcined for some hours at a low heat in a reverberatory with about fifteen per cent of common salt (or, as at Oker, in Germany, with crude chloride of potassium), gives up to water acidulated with a little chlorhydric acid its sulphur as sulphate of soda, and its copper and silver as chlorides, together with a considerable excess of common salt, leaving behind a nearly pure peroxide of iron with not over two thousandths of copper. A minute portion of gold, which was converted into aurous chloride during the roasting, is also present in the solution.* The lixivium, in an example given by Claudet, had a specific gravity of 1·24, and held in a meter-cube, besides 144·0 kilogrms. of sulphate of soda, 64·0 of chloride of sodium, and 52·8 of copper as protochloride, besides small portions of zinc and iron, with a little lead, and 44 grms. of silver. The above details of the self-roasting process, which have often been published, are here repeated, in order to bring more clearly before us the problem of separating the silver from the copper.

Various plans have been suggested for extracting from such solutions as the above the dissolved silver before throwing down the copper by metallic iron. It has been proposed to precipitate the silver by finely-divided metallic copper, as is done in the Augustin process from solutions of chloride of sodium holding only dissolved silver-chloride; but, since metallic copper at once converts protochloride into dichloride of copper, it becomes necessary, as a preliminary to the precipitation of the silver by this means, that the whole of the copper in the solution should first be brought into the latter condition. This may be effected by treating the hot solution with sulphurous acid, or by filtering it at a temperature near the boiling-point through a layer of coarsely-ground copper matte, or of vitreous or purple copper ore, from which, as I have found, a second equivalent of copper is taken up. From solutions holding the whole of the copper of dichloride, the silver may be readily thrown down in the metallic state by filtering them through a layer of finely-divided metallic copper; but, inasmuch as the dichloride requires to hold it in solution a great volume of hot concentrated brine,† this method of separating silver from solutions containing a considerable amount of copper is not in all cases practicable.

Among the plans which have been proposed for the separation of the silver from these saline solutions are those based on fractional precipitation. This is effected as at Oker, by the use of sulphide of sodium; or better, by diluted sulphuretted hydrogen gas, as got by the action of air mixed with carbonic acid on the waste calcium-sulphide from Leblanc's soda-process. In the latter case, the whole of the silver is, according to Gibbs, carried down with the first six per cent of the copper. Snelus blows finely divided metallic iron into the solution, and finds the first twenty per cent of copper thus precipitated holds four-fifths of the silver. For the extraction of the silver from the mixed sulphides, it suffices to convert the silver into a sulphate, as in the Ziervogel process. For the separation of silver from precipitated copper, J. A. Phillips, by a process patented in 1877, makes the material into a paste with water and a mixture of common salt and carbonate of soda; and, after calcination in a reverberatory, gets the silver in the form of chloride, which is dissolved out by brine from the oxidised copper.

The solvent power of solutions of chloride of sodium for chloride of silver is diminished by dilution, and upon this fact, apparently, is based a process for the separation of silver, patented in 1877 in Great Britain by Jardine and Chadwick, which consists in diluting the strong lixivium from the salt-roasted ore to about sp. gr. 1·10—1·12, and adding thereto, in the form of a dilute-solution, about half a pound of acetate of lead to the ton of liquid. The precipitate, which after a time separates, consisting, in large part, of sulphate of lead, carries with it a portion of chloride of silver, and, it is said, a trace of gold.

The most elegant method for the separation of silver from these mixed solutions is, however, that patented by Claudet, and extensively applied in Great Britain. It depends on the almost complete insolubility of iodide of silver in solutions of chloride of sodium, and consists in adding to the lixivium, in which the proportion of dissolved silver has previously been determined, a dilute solution of a soluble iodide just sufficient in amount to convert the whole of the silver into iodide of silver. The precipitate, which separates after forty-eight hours of repose, is washed with dilute chlorhydric acid, to remove adherent copper-salts, and then consists chiefly of a mixture of sulphate of lead with iodide of silver, which is reduced by metallic zinc, the iodine being thus recovered for further use. Treated in this manner, the calcined Spanish ores yield to the ton 20 grms. of silver containing 1·3 per cent of gold, amounting, according to Lunge, to about two-thirds the entire amount of precious metals contained in the ore. The presence of dichloride of copper in the solution interferes, by the production of a cuprous iodide, with the separation of the silver as iodide; and hence the calcination of the ores with salt must be so conducted as to give the copper in the condition of protochloride.*

The extraction of copper from its ores by roasting with salt is limited to pyritous ores poor in copper, which yield, by their previous calcination, a large proportion of peroxide of iron; the presence of this being necessary to the effectual chloridising of the copper in the furnace. When applied to richer ores, this method fails to render the whole of the copper soluble, for reasons which are made apparent by the investigations of Mr. Thomas Macfarlane, described by him in 1865. He found that while copper ores, such as chalcopyrite and bornite, when calcined with salt, either alone or with an admixture of pulverised quartz, yield but a small portion of their copper in the form of soluble chloride, such a mixture of ore and salt, with twice its weight of peroxide of iron, and a little pyrites to furnish additional sulphur, if calcined at a low temperature, and without stirring, gave up nearly all its copper to water as a soluble chloride. It was made evident, from these and other experiments described by Macfarlane, that the mass of heated peroxide of iron, in the presence of air, favours the conversion of the sulphur into a sulphate, through which the

* Plattner, as is well known, showed that gold, like silver, is chloridised when pyritous ores containing it are roasted at a low red heat with common salt; an aurous chloride being apparently found, which, in the presence of chloride of sodium, has a considerable degree of stability, though it is decomposed at higher temperatures. This chloride of gold is insoluble in water, and unlike chloride of silver, is not decomposed by mercury. It is but slightly soluble in brine, though readily dissolved by a solution of hyposulphite of soda or lime. A process proposed by Kiss for the simultaneous extraction of silver and gold from pyritous ores is based on these reactions.

† 100 c.c. of a solution holding 15·0 grms. of chloride of sodium, dissolve at 90° C., 10·0 grms; at 40, 6·0; and at 14°, 3·5 grms. of cuprous chloride; while 100 c.c. of a solution holding 5·0 grms. of chloride of sodium, dissolve at 90°, 2·6 grms, and at 50°, 1·4 grms. of cuprous chloride. This substance, contrary to the received statements, is not quite insoluble in water. When the cuprous chloride is boiled with distilled water, an amount equal to about 1·35 grms. to a litre passes into a solution, and is in part thrown down on cooling in a white crystalline form; the solution, at 14° C., still retaining about 0·90 grms. to the litre. The above numbers are only approximations.

* For an excellent account of wet processes for the extraction of copper see Friedr. Bode in *Dingler's Polytechnisches Journal* for January-March, 1877, vol. ccxxxi., pp. 254, 357, 428

decomposition of the common salt and the chloridising of the copper are effected.*

These conditions are most fully realised when a material like the calcined residue of Spanish pyrites, containing in 100 parts about 4 parts each of copper and sulphur, and 80 parts or more of peroxide of iron, is calcined with a sufficient amount of common salt, in which case, as we have seen, the chloridising of copper is nearly complete. Ignorance of these conditions has more than once led to failure in attempts to apply this process of copper-extraction.

Unlike the method of chloridising by roasting with salt, that depending on the use of a solution of ferrous chloride with salt is a general one, applicable to all naturally or artificially oxidised copper ores, which may be readily and cheaply chloridised by its aid.† When applied to copper ores containing silver, however, this shares with the salt-roasting process the disadvantage that the silver is at the same time chloridised, and if not present in too large an amount, is dissolved, while the dichloride of copper formed by the reaction between the oxide of copper and the ferrous chloride precludes the use of Claudet's method of precipitating the dissolved silver by a soluble iodide.

There is a large class of copper-bearing ores and furnace-products containing, besides silver, and in some cases gold, portions of antimony and arsenic, often accompanied by lead, the treatment of which, either by the wet or the dry way, offers many difficulties. A simple and economical general method, which will effect a complete separation of copper from silver and gold on the one hand, and from arsenic, antimony, and lead on the other, has hitherto been a desideratum in metallurgy. From the want of such a process, considerable quantities of refined copper extracted from Western ores and mattes, and carrying from 40 to 50 ounces of silver per ton, have of late years been sold in our markets.

With my friend, Mr. James Douglas, Jr., of Phœnixville, Pa., I have devoted much time to the metallurgical problem thus presented, and as the result of our joint labours have now to bring before the Institute of Mining Engineers a novel wet process for the extraction of copper from its ores, which will, I think, be found to meet the required conditions. The new method is based upon the reaction described by Wöhler between sulphurous acid and a solution of protochloride of copper, which gives rise to insoluble dichloride with the elimination of one-half the chlorine in the form of chlorhydric acid, and the simultaneous formation of sulphuric acid, as simply expressed in the old notation by the formula—

$$2CuCl + SO + HO = Cu_2Cl + HCl + SO_3.$$

The resulting acid solution, when brought in contact with cupric oxide, will take up as much copper as it originally held, which may, in its turn, be thrown down by sulphurous acid. In this way, the solution of copper from an oxidised ore, and its precipitation as dichloride, may be repeated indefinitely, provided chlorine be supplied each time by the addition of a sufficient amount of some soluble chloride.

The reaction between sulphurous acid and a solution of protochloride of copper goes on slowly at ordinary temperatures, but is very rapid between 80° and 90° C. Solutions of sulphate of copper mixed with an equivalent of chloride of sodium, and holding 8·0 per cent of copper, after being treated at 90° C. with an excess of sulphurous acid gas, retain less 1·0 per cent of dissolved copper; while in the presence of an excess of sulphate of copper and sulphurous acid the precipitation of the chlorine from chloride of sodium is nearly complete; sulphate of soda and sulphuric acid remaining in solution in accordance with the equation—

$$2CuO,SO_3 + NaCl + SO_2 = Cu_2Cl + Na,SO_3 + 2SO_3$$

The sulphurous acid gas for effecting this reaction on a large scale is readily got in sufficient purity from the burning of iron pyrites in the ordinary kilns used by the makers of sulphuric acid, care being taken that an excess of air be avoided. A Knowles pump, constructed for the purpose, has proved an efficient means of injecting the heated gas into the liquid. By this reaction, we have found it easy, in repeated trials with a small experimental plant, to throw down in three hours' time 125 pounds of copper from an 8 per cent solution, the liquid still retaining about 1 per cent of copper dissolved.

The acid liquors, when the reaction with sulphurous acid is complete, have exchanged their bright blue colour for a pale green, and now contain in solution an excess of sulphurous acid, which must be got rid of before using them to dissolve a fresh portion of copper. This may be effected by keeping back a small portion of the chloridised copper solution, and, after the action of the gas is complete, as may be known by the changed colour and the sulphurous odour of the liquid, adding the reserved portion thereto, by which means the excess of sulphurous acid will be oxidised. The chief part of the dichloride of copper separates during the passage of the gas, but a further portion is deposited on the cooling of the solution.

The excess of sulphurous acid may also be got rid of by blowing a current of hot air through the liquid after it has been withdrawn from the precipitated dichloride, and best while the process of saturating it with oxide of copper is going on. This, when got by the calcination of sulphuretted ores, contains more or less suboxide of copper,* which, with chlorhydric acid, forms a portion of cuprous chloride, and the separation of this, under these circumstances, may be prevented by the action of atmospheric oxygen.

Cuprous chloride is quickly transformed into cupric oxychloride by atmospheric oxygen, and, when dissolved or suspended in an acid liquid, is by this means readily converted into a cupric salt, which may be again reduced to cuprous chloride by the action of sulphurous acid. In this way, like the nitric oxide in the leaden chamber, the cuprous chloride acts a medium through which sulphurous acid and oxygen are made to combine and to form sulphuric acid. The two reactions of oxidation and reduction just described may go on alternately or simultaneously in the liquid, and thus it happens that when an excess of air enters the pyrites-kiln, so that considerable free oxygen passes with the sulphurous acid into the copper solution, the dichloride is either separated slowly or not at all, while at the same time much sulphuric acid is formed. By taking advantage of these reactions between oxygen, sulphurous acid, and chloride of copper, we may at will increase the solvent power of our acid bath.

In applying this new process of copper extraction to a roasted sulphuretted ore or matte, which we will suppose to contain a portion of silver, we begin by dissolving therefrom by water the sulphate, which, with proper care in roasting, should contain not less than one-third of the copper of the ore; taking care to add to the water enough of some soluble chloride to chloridise and render insoluble any sulphate of silver which may be present. From the clear lixivium thus obtained, after adding the requisite amount of chloride of sodium, the copper is precipitated, as already described, by the action of sulphurous acid gas. The resulting acid liquid, freed from the excess of sulphurous acid by the addition of a reserved portion of the original solution containing copper chloride, and still retaining more or less copper, is now used to dissolve the oxide of copper from a portion of the lixiviated ore; the process being aided by heat, and, if the formation of dichloride of copper is to be feared, by the injection of a current of air, which may be made the means of heating

* *Canadian Naturalist*, Second Series, vol. ii., pp. 219, 231, and vol. iii, p. 457.

† A process of copper-extraction, based on this principle, is the subject of United States letters-patent, granted to T. Sterry Hunt and James Douglas, Jr., February 9th, 1869.

* I have found calcined sulphuretted copper ores to contain, in addition to soluble cupric sulphate and insoluble oxides of copper, a small portion of a cuprous compound, which, though insoluble in water, is dissolved by a hot and strong solution of common salt, and is probably a cuprous sulphate or sulphite.

and agitating the mixture. If the ore contains silver, either in the form of metal or unoxidised sulphide, we have in the chloride of copper which is formed the best agent for bringing it to the condition of chloride of silver. This will be found in the residue after the extraction of the copper, together with any gold which may be present, lead as sulphate, oxides of antimony and iron, and earthy matters. Cobalt, nickel, and zinc, if present, will, however, be dissolved, and, not being precipitated by sulphurous acid, will, by successive operations, accumulate in the solution, and may afterward be extracted.* From the residues thus deprived of copper we have found the silver to be readily dissolved by brine,† after which, if gold be present, it may be removed by chlorination, or the two precious metals may be extracted together from the residues by amalgamation. When, as in the case of certain mattes from Utah, for example, the residues contain a large amount of lead as sulphate, this may be recovered by smelting, and a base bullion got containing the precious metals. The same result may also be attained by smelting the residues with an admixture of a lead ore.

Chloride of silver is soluble to some extent in solution of cupric chloride, and is then in part carried down with the cuprous chloride in the precipitation of the latter. The formation of cupric chloride may be avoided by adding to the solution of sulphate of copper little more than the amount of chloride of sodium necessary for the conversion of the copper into dichloride. In this case, as we have seen, the acid liquid after precipitation by sulphurous acid will contain chiefly sulphuric acid, though still holding sufficient cupric chloride to effect the chloridising of any silver which may be present in the ore.

The dichloride of copper, as obtained by precipitation, is a white, coarsely crystalline powder, having a specific gravity of 3·376 (Playfair and Joule), and, as we have seen (second note, column 1, p. 199) is nearly insoluble in cold water. After being washed from the acid liquid, it may be readily reduced by placing metallic iron in the moist dichloride, which should be covered with water to exclude the air. The action spreads rapidly through the precipitate, so that a single mass of iron will, in a few hours, change a considerable volume of dichloride around it into pure spongy metallic copper. The reduction of copper from solutions obtained in those wet processes where the copper exists as protochloride, often accompanied by salts of iron, entails a considerable loss of metallic iron, and gives a copper which is impure from the presence of basic iron salts. The reduction of the solid dichloride, however, presents none of these disadvantages. Forty-five parts of iron suffice to reduce 100 parts of copper; the precise ratio being as 28·0 : 63·4. The ferrous chloride which remains in solution may with advantage be used instead of chloride of sodium for chloridising subsequent solutions of sulphate of copper, ferrous sulphate being formed, which, as it accumulates, may be separated by crystallisation from the acid liquid. The ferrous dichloride required to chloridise 20 parts of copper would equal about 61 parts of hydrated ferrous sulphate.

Another mode of treating the dichloride, which may in some cases be resorted to, consists in decomposing it, best at a boiling-heat, with a slight excess of milk of lime. The dichloride is by this means converted into a dense orange-red suboxide of copper, which, after being washed from chloride of calcium, in a filter-press or otherwise, and dried, may be readily reduced to metallic copper in a reverberatory furnace. For this reaction 28 parts of pure quicklime are required for 63·4 parts of copper, and the resulting chloride of calcium may be used instead of chloride of sodium or chloride of iron for chloridising solutions of sulphate of copper. In this case there will be formed an insoluble sulphate of lime or gypsum, while the free sulphuric acid of the solution is replaced by chlorhydric acid. The use of the chloride of calcium would, however, require an additional operation, since, to avoid the presence of the precipitated gypsum either with the dichloride or the undissolved residue of the copper ore, it would be necessary to add the chloride of calcium to the clear copper solution, and, after allowing time for the gypsum to subside, to transfer the liquid to the vats in which the copper is to be precipitated by sulphurous acid. There may, however, be localities in which the cost both of metallic iron and of common salt is such as to render advantageous the decomposition of the dichloride of copper by lime, provided there is no silver to be extracted.

We have heretofore considered only the case in which the acid liquor got by precipitating the copper from neutral solutions in the form of dichloride is used to dissolve successive portions of oxide of copper alone. This can be done in the case of pure ores free from other strongly basic oxides, if without loss, yet without any gain of acid save what comes incidentally from the portion of sulphuric anhydride which is given off in the calcination of pyrites, or from the reaction between sulphurous acid and oxygen in the presence of chloride of copper, as already explained. If, however, as is more often the case, we are treating artificially oxidised sulphuretted ores or mattes, which yield by roasting a mixture of oxide and sulphate of copper, it will be apparent that by the repeated use of the present process there must result a constantly augmenting proportion of free acid in the liquid.

This may be made clearer by examples. Let us suppose a solution holding in a cubic foot (equal 1000 ounces of water) 63·4 ounces or two equivalents of copper in the form of sulphate. To convert this into protochloride would require two equivalents, or 117 ounces of chloride of sodium; but for the production of the dichloride, as we have seen, one equivalent, or a little more, will suffice, or, in place thereof, a corresponding amount of ferrous or calcic chloride. When, by the action of sulphurous acid, the whole of the copper is reduced to the cuprous condition, and in a great part thrown down as dichloride, the previously neutral solution will contain two equivalents or 98 ounces of sulphuric acid* (oil of vitriol), which, if a larger amount of chloride had been added, would be in part replaced by chlorhydric acid. These two equivalents of acid are capable of taking up two equivalents, or 79·4 ounces, of oxide of copper, after which the solution will contain, as at first, 63·4 ounces of copper. If, however, we add to this acid solution, instead of simple oxide of copper, a calcined ore or matte in which one-third of the copper is present as soluble sulphate, and two-thirds as oxide, it is clear that when the acid is saturated we shall have in the liquid, besides the 63·4 ounces of copper from the oxide, one-half as much more, or 31·7 ounces of copper which were already present as sulphate in the roasted ore; making in all three equivalents, or 95·1 ounces, of dissolved copper, which are, in their turn, to be converted into dichloride. Now, as the amount of acid set free in this reaction is equal to that originally combined with the copper, it follows that the liquid after the precipitation of the dichloride will contain three equivalents of acid, instead of two as before. If to this we add, a second time, enough of the mixture of two-thirds oxide and one-third sulphate of copper to neutralise these three equivalents, we shall have four and a half equivalents of dissolved copper, from which, by a third repetition of the process of precipitation by sulphurous acid, four and a half equivalents of sulphuric acid would be set free; so that in place of 98 ounces we should have 220½ ounces in the solution,—an amount which a fourth repetition of the process of saturation and precipitation would raise to six and three-quarter equivalents, or 330 ounces of oil of vitriol.

* For observations on the association of nickel and cobalt with certain copper ores, see Appendix I.

† For notes on the solubility of chloride of silver in solutions of common salt and other chlorides, see Appendix II.

* While we recognise the dyad nature of copper, oxygen, and sulphur, and the bibasicity of sulphuric acid, it is simpler and more convenient for the calculations of the manufacturing chemist and the metallurgist to use, as we have done in the present paper, the older notation, and to speak of 31·7 parts of copper, 8 parts of oxygen, 40 parts of sulphuric oxide, 49 parts of oil of vitriol, 36·5 parts of chlorhydric acid, and 58·5 parts of chloride of sodium as equivalents.

If, instead of a mixture containing one-third of its copper as sulphate, we have one in which only one-fourth is sulphate and three-fourths are oxide, we should get, by saturating with this a solution containing two equivalents of acid, and subsequent precipitation with sulphurous acid, a liquid holding 2·66 equivalents of free acid, which by a third repetition of the process would yield 3·55, and by a fourth 4·73, equivalents of free acid, in place of the two equivalents which were present after the first precipitation.

The above calculations are founded on the supposition that the roasted ore or matte contains, besides the oxide of copper, no base that would be attacked by dilute acids. In fact, however, oxides of lead, zinc, and, more rarely, nickel and cobalt, may accompany the copper oxide, and give rise the first to an insoluble and the others to soluble sulphates, consuming more or less acid. Ores containing more or less carbonate of lime (often with carbonate of magnesia) are also of frequent occurrence, and here is seen a great advantage which this mode of copper extraction possesses over all the other wet processes; for since lime and magnesia, and their carbonates, not only neutralise free acids, but throw down copper from its solutions, the treatment, by these processes, of ores containing any considerable proportion of calcareous matter, is impracticable. With the process here proposed, which generates an abundance of free acid, the extraction of copper from ores which do not contain an excessive amount of calcareous matter presents no difficulty except such as arises from the mechanical obstacle created by the formation of gypsum in the solutions. The accumulation of acid in the bath is, indeed, so rapid in many cases that it will become unnecessarily strong, and may be diluted with water; while that portion not needed, after being deprived of the last portions of copper by the action of metallic iron, may be rejected unless it retains in solution other metals of value.

It will be seen, from the foregoing description, that the new process here described resembles those which, at the beginning of this paper, we have placed in Class II., inasmuch as the oxidised copper is separated from foreign metals by dissolving it in sulphuric and chlorhydric acids, with the difference, however, that the acids for this purpose are generated in the process itself, by the action of sulphurous acid, while the copper is separated from its solutions in the form of dichloride; the reduction of which to pure copper is readily effected by the consumption of a minimum amount of metallic iron. At the same time, any silver or gold which may be present in the ore is left undissolved, and in the best condition for subsequent extraction by well-known methods, while the saving of cobalt and nickel, of lead, or of antimony, should these be present in quantities of economic importance, may be subsequently effected by very simple processes.

The apparatus for this new general method of copper extraction is simple and inexpensive. The chlorine required in the precipitation of the copper being recovered for further use, the only reagent consumed, except the sulphurous acid,—which is a waste product from the roasting of sulphurous ores,—is an amount of iron which is equal to less than one-half the weight of the copper, and may be recovered in the form of sulphate of iron, or, instead thereof, the same quantity of caustic lime.*

Appendix I.

The presence of small portions of cobalt and nickel in cupriferous pyrites is not uncommon, and mixed earthy oxides of copper, nickel, and cobalt have been found in considerable quantities in Missouri. A greenish, translucent, amorphous mineral, with black stains, resembling chrysocolla in appearance, from some place in Western Nevada, where it was said to have been abundant, and to have been mined for the manufacture of sulphate of copper, was brought to me in 1876, and found to contain considerable quantities of both cobalt and nickel. One of two closely agreeing analyses by my former pupil, Mr. Hardman, made at the Massachusetts Institute of Technology in 1877, gave for this mineral as follows:—Oxide of copper, 9·63; oxide of nickel, 3·23; oxide of cobalt, 3·88; peroxide of iron, 3·08; peroxide of manganese, 2·40; lime, 1·04; magnesia, 0·10; alumina, 13·01; silica, 42·97; water, 18·38 = 97·72. The cobalt and nickel were separated by Rose's method. Another analysis, in which these metals were separated by the method of Fischer, with nitrite of potassium, gave of oxide of cobalt, 4·11. Such an ore, if abundant, would be a valuable source of both nickel and cobalt.

This aluminous mineral, like chrysocolla (see second note, col. 2, p. 198), is attacked by a solution of ferrous chloride and common salt, by which the oxides of cobalt and nickel are indirectly dissolved; since, although they have not the power of decomposing ferrous chloride, they decompose the cupric chloride which is formed by its reaction with cuprous oxide.

Appendix II.

As regards the solubility of chloride of silver in solutions of chloride of sodium, Vogel found that 1 litre of a saturated solution, at ordinary temperatures, held dissolved 0·950 grm. of chloride of silver, while, according to Hahn, a litre at 19·6° C. holds 1·269 grms. Becquerel found at ordinary temperatures for a similar solution 0·800 grm. to the litre: 100 parts of water, saturated at 100° C., holds 26·61 parts, and at 15·6° C. 26·34 parts, of chloride of sodium, the densities of the solutions being respectively 1206·93 and 1204·03. Hence 1 litre of a saturated solution at 15·6° holds 316 grms. of common salt, 1000 parts of which solution under these conditions dissolve, according to Hahn, at 15·6° C., 3·0 parts of chloride of silver; while, according to the observations of Vogel and of Becquerel, at "ordinary temperatures," not defined, 1000 parts in saturated solution dissolve respectively 4 parts and 2·53 parts of chloride of silver. The latter figure approximates to that given by Pelouze and Frémy, according to whom 1000 parts of salt at 18° C. hold dissolved 2·40 parts of chloride of silver. The solvent power, according to these chemists, varies greatly with the temperature, the amount dissolved being equal to 1·70 parts at 10° C., and not less than 6·80 at 100° C., while at 0° C. but traces of chloride of silver are dissolved. Differences of temperature may suffice to explain the discrepancies between the results of Vogel, Hahn, and Becquerel, but not those of Pelouze and Frémy at 18·0° C., a temperature above that mentioned by Hahn. It is possible that these chemists may not have employed solutions saturated with chloride of sodium, to which the observations of the others refer. Fresenius, speaking of the solubility of chloride of silver in hot concentrated solutions of the chlorides of sodium, potassium, ammonium, calcium, zinc, &c., says:—"On sufficient dilution with cold water, the dissolved portion separates so completely that the filtrate is not coloured by sulphuretted hydrogen."*

As to the solubility of chloride of silver in some other chlorides, Hahn found that a litre holding 30·70 per cent of ferrous chloride, and having a specific gravity of 1·419 dissolves, at 20° C., 2·385 grms. of chloride of silver; while a solution holding 44·48 per cent of cupric chloride, and having a specific gravity of 1·5723, dissolves at 30° C., for 1 litre, 0·836 grm. of chloride of silver. For further observations on the solubility of chloride of silver in other chlorides, see Percy, *Metallurgy of Silver and Gold*, Pt. I., p. 58, and also Hahn, *Transactions American Institute Mining Engineers*, vol. ii., p. 99.

On Caryophylline.—E. Hjelt.—Caryophylline has the formula $C_{40}H_{64}O_4$. Its isomerism with camphor appears accidental.—*Berichte der Deutschen.*

* United States Letters Patent, No. 227,902, for this method of copper extraction, were granted to Thomas Sterry Hunt and James Douglas, jun., May 25th, 1880.

* Fresenius, "Quantitative Analysis," Amer. Ed., 1879, p. 124.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. X.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Continued from p. 190.)

(68.) *Analysis of Wulfenite from Ruby Hill, Eureka Co., Nevada.* By C. L. ALLEN, of Charleston, South Carolina.

Among a number of specimens of crystallised wulfenite sent me from the above locality in Nevada there were some which there was reason to suppose might contain calcium molybdate in considerable proportion. An analysis of the mineral was made by Mr. Allen in order to determine this point. The material, formerly found in quite large quantity, is well crystallised, of a bright orange-yellow colour, and of sp. gr. = 6·701. The molybdenum was precipitated from a solution of ammonium sulphomolybdate, and a definite portion of the precipitate reduced to disulphide by cautious ignition in hydrogen. The results of the analysis were—

MoO_3	39·33
PbO	61·11
CaO	1·04
Fe_2O_3	0·38
	101·86

Not very accurate work, but sufficient to show that there is no large amount of calcium present, and that the mineral from this locality—of which I believe no analysis has hitherto been published—has no marked peculiarity of composition.

(69.) *On the Possibility of Artificially Preparing Amorphous Elementary Carbon Free from the Gaseous Elements, Hydrogen, Oxygen, and Nitrogen.* By SAMUEL PORCHER, of Hanover Court-House, Virginia.

It is well known that black amorphous carbon prepared from any form of organic matter as a residue from destructive distillation or imperfect combustion retains obstinately small quantities of hydrogen, oxygen, and (if nitrogenous matter be used) nitrogen, which cannot be driven off by exposure to any attainable temperature. It is an interesting question whether these gaseous impurities exist in chemical union with the carbon or are retained by surface attraction only, such surface condensation undoubtedly occurring to a large extent on exposure to the atmosphere, though much, if not all, of the gaseous matter so condensed *may* be driven off again by heat. With a view to obtain some light on this question it was proposed that carbon should be prepared from materials altogether free from the elements in question, that its weight should be determined; it should then be exposed to the atmosphere, heated again, and the product after cooling examined as to the presence of any of the three other elements named, hydrogen if found being of course attributable to vapour of water. These experiments were undertaken by Mr. Porcher, and some progress made with them, when they were unfortunately interrupted by his serious illness, which prevented their completion before the end of the College year. The following partial results, however, may be worth recording.

The carbon was prepared by passing the vapour of carbon tetrachloride over metallic sodium, very carefully freed from any traces of naphtha, in a hard glass tube, taking care to expel all air before heating the metal. To protect the glass, a layer of pure, well-burned lime was placed on the lower side of the tube, and on this, well pressed down, the sodium rested. In spite, however, of this precaution, the energy of the reaction caused the volatilisation of some of the metal, and the upper part of the glass was attacked, introducing silicon into the product. To avoid this, the lime was in the later experiments placed in a loose inner tube of copper-foil. Platinum was tried, but was itself extensively attacked. Some of the carbon left could be mechanically detached from the upper face of the lime, but up to the time when the experiments were broken off none had been directly obtained free from calcium and copper, which had to be removed by prolonged treatment with nitric and hydrochloric acids and washing with water. The amount of ash left from the combustion of the products first obtained was quite large, but finally a specimen was obtained which was almost perfectly free from fixed impurities.

After being heated to a temperature not much below that at which it would have begun to burn, and then burned in a little platinum boat in a stream of very carefully purified and well dried oxygen, the products of combustion collected as in ordinary organic analysis, one specimen gave absolutely no water, thus indicating the absence of either condensed aqueous vapour or combined hydrogen, while a minute loss on the weight of the original material was probably attributable to the carbon not being completely burned, traces being retained in the ash, which was in this case present in considerable amount.

(70.) *On the Absorption of Chlorine by Arsenious Chloride, and the Amount Retained at Various Temperatures.* By B. E. SLOAN, of Charleston, South Carolina.

Notwithstanding the failure which has hitherto attended all attempts to produce a pentachloride of arsenic, it seemed worth while to examine the effect of exposing the trichloride to gaseous chlorine at low temperatures, observing to what extent the gas was absorbed, and whether any indications could be obtained of true chemical combination.

Pure arsenic trichloride was prepared by the direct action of chlorine on the metal, and the product was carefully rectified from a second retort, access of atmospheric moisture to the receiver being guarded against by a sulphuric acid tube, and the surplus chlorine carried off into a large jar of slaked lime. This trichloride was now placed in a long-necked flask, immersed in a properly protected bath of crushed ice and hydrochloric acid, and chlorine gas, well dried and previously cooled, was slowly bubbled through for eight hours, maintaining throughout a temperature of $-23°$ C., under ordinary pressure, about 745 m.m. At the end of this time a sample, about 20 c.c. of the liquid was drawn off into another cooled flask using a special arrangement of tubes to prevent any gaseous chlorine being brought with it, and to obviate any general contact with the atmosphere. The liquid was received in a short dry test-tube, supported in a vertical position by freezing some water round it in the bottom of the flask, while a second test-tube contained a sufficient amount of a strong solution of sodium hydrate for the complete decomposition of the chloride. This receiving flask with its appurtenances, including a stopper, which had been accurately weighed beforehand, was now allowed to stand for some hours to acquire the temperature of the laboratory, was then again weighed, so that the exact amount of the chloride introduced was known; the mixture of the latter with the soda solution was gradually made complete, the mixed solution was diluted to a definite volume, and in separate portions of this the chlorine and arsenic were separately determined. The results showed 4·447 atoms of chlorine for 1·0 of arsenic. As a lower temperature could hardly have been used without risk of simply liquefying the chlorine itself, and as other experiments showed that the time employed was much more than sufficient to allow of all the gas being taken up that would dissolve, it was obvious that a pentachloride had not been formed.

The stability of the liquid formed at −23° was then examined by exposing separate samples of it to various higher temperatures for considerable lengths of time, and analysing the residual products. During the exposure of each sample, simple evaporation was guarded against by closing the mouth of the little containing flask with a stopper through which passed a tube, open at both ends, containing solid sodium hydrate, which was washed out of the tube afterwards, and chlorine and any arsenic in the solution determined. The results obtained as to the composition of the liquid were—

			Atoms Cl for 1 at. As.
After 2 hrs. 30 mins. at	−23° to −19° C.*	..	4·324
,, 1 hr.	,, −19 − 6	..	4·292
,, 10 hrs.	,, − 6 +15	..	4·233
,, 8 hrs. 30 mins.	,, 15 24	..	4·080

The rate of loss of surplus chlorine being slower than might have been expected on the supposition of its existing merely in a state of physical solution, and the apparent tendency of the above figures to a ratio of 4 atoms chlorine for 1 atom of arsenic suggested the possible existence of a compound, As_2Cl_8, in which arsenic would appear as a pentad. Another specimen, however, of the liquid product obtained as above, the first supply having been exhausted, was exposed to a still higher temperature—viz., 37° C.—and was afterwards found to contain but 3·33 atoms of Cl for 1 of As. This specimen was *prepared* at a much higher temperature than the former, the advance of the season having made it very difficult to work with freezing mixtures for any considerable time, and this fact, coupled with the rather abrupt change of composition observed between the specimens exposed to 24° and 37° respectively, makes it still conceivable, though perhaps not very probable, that an unstable compound, As_2Cl_8, may exist.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 10, September 5, 1881.

Carbonated Ferruginous Waters.—J. Ville.—Alkaline and alkaline earthy bicarbonates do not affect ferruginous waters. Chlorides and sulphates retard in a marked manner the decomposition of such water on exposure to the air.

No. 11, September 12, 1881.

Comparative Qualities of the Waters of the Isère and the Durance for the Purposes of Irrigation.—M. de Gaspardin.—The author gives a comparative analysis of the two waters. The results are of merely local interest.

New Process of Working Mines of Sulphur.—MM. de la Tour du Breuil.—The authors boil out the sulphur from its gangue in a solution of chloride of calcium containing 66 per cent of the solid salt and having its ebullition-point at 120°. This solution attacks neither the sulphur nor the gangue. In this manner the sulphur is extracted in a state of great purity, at the cost of 5 francs per ton, and without the production of any nuisance.

Radiophony Produced by Lamp-black.—E. Mercadier.—Lamp-black is not merely pre-eminently the thermophonic agent, but it may, like selenium, act as an electric photophone. The author referring to the double coil receivers, which he described *Comptes Rendus*, xcii., p. 789, states that, instead of selenising one of their surfaces, it may be blackened by exposure to the smoke of an oil lamp, taking care not to carbonise the parchment paper, which isolates the metallic coils from each other.

Explanation of a Contrast in Circular Double Refraction.—M. Croullebois.—A mathematical paper, not susceptible of useful abstraction.

Magnetic Metals.—M. Gaiffe.—Cobalt is much more strongly magnetic than nickel.

Metaldehyd.—MM. Hanriot and Œconomides.—Metaldehyd is insoluble in water, almost insoluble in alcohol, tolerably soluble in aldehyd. Its best solvents are chloroform and benzol. It has been heated to 200° in sealed tubes for four hours without being converted into aldehyd to the extent of more than one-half.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin Vol. 13, No. 7.

Certain Compounds of the Leuko-base from Cuminol and Dimethyl-aniline.—J. Ziegler.—The base is obtained according to Otto Fischer's process. The author describes the hydrochlorate, picrate, iodmethylate, the platinum double salt, and the action of nitric acid. By oxidising the base, colouring-matters are obtained almost identical with benzol green.

The Ureides.—J. M. A. Kramps.—The author has examined the action of chlorine and bromine upon sulphydantoin.

Problem to Determine the Number of Isomeric Paraffins of the Formula C_nH_{2n+2}.—F. Hermann.—The numbers of the possible isomeric paraffins of the formulæ $C_{12}H_{26}$ and $C_{13}H_{28}$ are respectively 355 and 802.

Action of Sodium upon Turpentine Hydrochlorate.—E. A. Letts.—When all the chlorine has been removed from the hydrochlorate the product yields on distillation a white solid, which boils at about 157°. In addition to this main product there passes over at about 330°, a yellowish white liquid.

Action of Ammonia upon the Ethyl-esters of Camphoronic Acid.—E. Hjelt.—On passing dry ammoniacal gas into an alcoholic solution of the mono-ester, there was obtained the corresponding mono-amide. A more permanent amide was obtained by a similar process from the diethyl-camphoronate.

Colouring-Matters Obtained by the Action of Naphthol upon Diazo-azobenzol.—R. Nietzki.—The author points out certain inaccuracies in the memoir of W. v. Miller (*Berichte*, xiii., p. 542).

Sequel to a Notice on New Colours.—W. v. Miller.—The author admits the priority of H. H. Caro and Schraube as regards certain points advanced in his memoir (*Berichte*, xiii., p. 542).

Composition of Barium Dioxide Hydrate.—Em. Schœne.—The author maintains his formula for this compound, $BaO_2,8H_2O$, against Berthelot, who ascribes to it ten molecules of water.

Condensation-Products of Tertiary Aromatic Bases.—Otto Fischer.—The author has studied the behaviour of the three isomeric dimethyl-toluidines with benzaldehyd. The para- compound does not react in presence of zinc chloride, even at 120° to 130°. The ortho-compound reacts, but with much more difficulty than dimethyl-aniline. The base was obtained in very small quantities, and its homology with tetra-methyl-diamido-triphenyl-methan is undecided. The meta- compound reacts as easily as dimethyl-aniline.

A Product of the Action of Aqua Regia upon Orcine.—S. Reyman.—The result of the reaction is a chlorine substitution-product of the colouring-matter obtained by Liebermann by the action of nitrous acid upon orcine.

* The temperature was allowed to rise gradually, but was most of the time at the higher point named.

Volatile Chlorides.—V. Meyer and H. Züblin.—Tin chloride seems to exist in the gaseous state in two modifications. In lower temperatures it is Sn_2Cl_4. but at higher temperatures it is resolved into molecules of $SnCl_2$.

Meta-para-dinitro-benzoic Acid Obtained by the Nitration of Para-nitro-benzoic Acid.—A. Claus and W. Halberstadt.—The author has obtained a new—the fifth—dinitro-benzoic acid by the nitration of para-nitro-benzoic acid.

History of Phenyl-acetamide.—Aug. Bernthsen.—Phenyl-acetamide was obtained in quantity from benzyl-cyanide, and described in 1873 by Weddige, and in 1876 by the author.

Bulletin de la Société Chimique de Paris.
No. 10, May 20, 1881.

Volumetric Liquid for the Determination of Super-oxygenised Compounds or such as Act as Oxidisers. A. Terreil.—The composition of the liquid is—

Ferrous sulphate .. .. 100 grms.
Concentrated sulphuric acid .. 200 ,,

The iron sulphate is dissolved in about half a litre of water, the sulphuric acid is then added and water enough to make up 1 litre when the mixture is cold. The solution is then titrated with a standard solution of potassium permanganate. Natural manganese ores, if finely powdered, may be determined in a few minutes. If lead or barium is present in the ore a few c.c. of hydrochloric acid should be added.

No. 11, June 5, 1881.

Action of Nitric Acid and the Metals.—E. J. Maumené.—If tin and nitric acid could be brought to act upon each other in infinitely thin strata, the result would be simply stannous oxide and ammonia.

Explosive Qualities of Mercury Fulminate.—MM. Berthelot and Vieille.—Already noticed.

No. 12, June 20, 1881.

Preparation of Chlorine.—M. Berthelot.—Already noticed.

Russian Chemical Society.—Session of Dec. 5/17, 1880.—A. Krakau.

M. Lebedinsky presented a communication on allyl-di-iso-propyl-carbinol and on the di-iso-propyl-ethyleno-lactic acid derived from this alcohol.

A note was presented by M. Chirokoff on the transformation of oxy-valeric acid into iso-propyl-acetic acid, and on iodo valeric acids.

M. Beketoff gave a communication on the reciprocal displacements of the halogens.

M. Diaconoff described an apparatus for drying gases.

M. Andreeff exhibited an automatic apparatus for washing precip tates, acting in a periodic manner.

M. Melikoff submitted a memoir on the derivatives of acrylic acid.

M. Kowalewsky has undertaken a study of the electrolysis of aqueous solutions of zinc sulphate.

M. Potilitzine explained the continuation of his researches on the speeds of reactions and on the law of distribution.

MISCELLANEOUS.

The Royal Institution.—The Session will commence with a course of six lectures on Astronomy, adapted to a juvenile audience, by Prof. R. S. Ball, F.R.S., Astronomer Royal in Ireland. Dr. Wm. Huggins will give a discourse on Comets at the first Friday Evening Meeting, January 20th, 1882.

King's College Science Society.—This Society, which is open to all past and present students of King's College, London (the annual subscription being 5s, and the entrance-fee 2s. 6d.), will hold its first meeting this Session on Tuesday, the 25th inst., in the Physical Lecture Theatre, when Prof. W. G. Adams, M.A., F.R.S., will give a lecture on "Grove's, Planté's, and Faure's Secondary Batteries. The chair will be taken at 8 p.m. Admission by ticket only. Applications should be made to the Secretary of the Science Society, King's College, Strand, W.C.

Strontianite.—Since it has been shown by Professor Scheibler, of Berlin, that strontium is the most powerful medium of extraction in sugar refinery, owing to its capacity of combining with 3 parts of saccharate, the idea suggests itself that the same medium might be successfully employed in the Arts, and form a not uninteresting subject of speculation for the chemist. Hitherto native strontianite—that is, the 90 to 95 per cent pure carbonate of strontia (not the cœlestine which frequently is mistaken by the term Strontianite)—has not been worked systematically in mines; but what used to be brought to the market was an inferior stone collected in various parts of Germany, chiefly in Westphalia, where it is found on the surface of the fields. Little also has been collected in this manner, and necessarily the quality was subject to the greatest fluctuations. By Dr. Scheibler's important discovery a new era has begun in the matter of strontianite. Deposits of considerable importance have been opened in the Westphalian districts at a very great depth, and the supply of several ten thousand tons per annum seems to be secured, whereas only a short time ago it was not thought possible that more than a few hundred tons could in all be provided. The interests in the various mines are, as it appears, amalgamated, and a syndicate has been formed which is represented in London by Messrs. Zimmermann.

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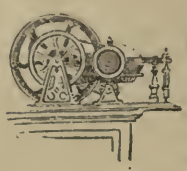

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THE CHEMICAL NEWS.

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NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. X.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Concluded from p. 204.)

(71.) *Analysis of Felspar accompanying Microlite, in Amelia Co., Virginia.* By B. E. SLOAN, of Charleston, South Carolina.

In the vein of coarse granite, about a mile from Amelia Court-House, in this State, from which large sheets of mica are obtained for commercial purposes, and in which the rare mineral microlite has been found,* along with brilliantly phosphorescent fluorspar, columbite, and great crystals of beryl, there occur crystalline masses of a beautiful felspar, nearly white, with a faint bluish green tinge, highly cleavable, with a brilliant vitreous, slightly pearly lustre on the principal cleavage faces; sp. gr. = 2·501. The general appearance is that of oligoclase from some localities, but Mr. Sloan's analysis shows that the mineral is orthoclase. He found—

		Atomic Ratios.	
SiO_2	65·37		1·0895—5·96
Al_2O_3 ..	18·74	0·1837	0·1845—1·01
Fe_2O_3 ..	0·13	0·0008	
CaO	0·27	0·0048	
K_2O	12·98	0·1378	0·1828—1·00
Na_2O ..	2·49	0·0402	
	99·98		

Agreeing closely with the normal tri-silicate formula.

(72.) *On a Zinc-bearing Clay from the Neighbourhood of the Bertha Zinc Mine, Pulaski Co., Virginia.* By B. H. HEYWARD, of Charleston, South Carolina.

This compact, lithomarge-like clay occurs at the locality named, in a seam of several inches thickness, overlying the deposit of calamine. It is light reddish yellow in colour, cuts under the knife like meerschaum, and on a cut surface exhibits a grained texture like that of wood. With water it forms a plastic mass, which is quite tenacious, becomes rigid on drying, and becomes pretty hard in the fire. It is partially decomposed by strong hydrochloric acid, and more completely by concentrated sulphuric acid on heating. Analysis gave—

SiO_2	37·38	
Al_2O_3	24·67	
Fe_2O_3	6·34	
ZnO	12·10	
MgO	0·27	
K_2O	0·47	
Na_2O	0·27	
H_2O (expelled on ignition over blast-lamp)	10·35	17·04
Do. (lost at 100° C.)	6·69	
	98·54	

* *Amer. Chem. Jour.*, May, 1881, 130.

On digestion with acetic acid the zinc, or at any rate a large proportion of it, was found to be soluble, perhaps existing in the clay as hydrate, though more probably as silicate (calamine), in a state of fine subdivision, and uniformly mixed with the aluminous silicate of the clay.

(73.) *Examination for Iodine of the Mother-Liquors from Salt Brines of West Virginia.* By A. L. BAKER, of Baltimore, Maryland.

A few years ago the remarkable statement was published* that the "bitterns" left from the manufacture of salt by boiling the natural brines of West Virginia and eastern Ohio, which have furnished very large quantities of bromine, contain, in addition to this element, about one-third its weight of iodine. This assertion seemed very improbable, but as no direct refutation of it was to be found in the shape of accurate determinations of the presence or absence of iodine in these mother-liquors, and of its amount if present, it was desirable that such an examination of these should be made. I am indebted to Dr. J. P. Hale, of Charleston, West Virginia, for four samples of "bittern," viz.—

No. 1.—Snow Hill furnace, Kanawha Co., W. Va.
No. 2.—Daniel Boom furnace, Kanawha Co., W. Va.
No. 3.—Newcastle furnace, Mason Co., W. Va.
No. 4.—Hartford City furnace, Mason Co., W. Va.

He informs me that, while these mother-liquors vary somewhat in strength from time to time at the same and at different salt-boiling furnaces, the variation is not very great, and that usually from 5 to 7 per cent of the brine as it comes from the wells is left as bittern, of which bittern 20 to 30 gallons will yield 1 pound of bromine.

These specimens all consisted essentially of very strong solutions of calcium, magnesium, and sodium chlorides, the first largely predominating, with enough free hydrochloric acid to give a distinct acid reaction with litmus paper. The specific gravities at 15° C. were—

No. 1.—Snow Hill	1·305
No. 2.—Daniel Boom..	1·270
No. 3.—Newcastle	1·300
No. 4.—Hartford City	1·285

It was found that part of the iodine—in one specimen all of it—existed in the free state, and could be collected directly by agitation with carbon disulphide. It was remarkable, however, that on dilution with water the amount that could be thus collected diminished. A good deal of difficulty was encountered in determining correctly the combined iodine, the other substances present sensibly interfering with its separation. The results obtained were only accepted as satisfactory after they had been checked by comparative experiments made with an artificial brine of the same general composition as the natural, but originally free from iodine, to which known amounts of standard dilute potassium iodide solution were added. It was found that potassium nitrite and *citric* acid answered best for the liberation of the iodine from iodides present; it was then taken up by carbon disulphide, and the amount determined by decolouration with a standard solution of sodium thio-sulphate. No difference in the quantity obtained was produced by the previous addition of arsenious acid; hence iodates were absent.

A number of experiments proved the following amounts of iodine to be present:—(See Table next column.)

Taking the mean of the above results, and calculating on the basis of the returns of West Virginia salt production in 1876, and Dr. Hale's statements as to the ratio of bittern to salt turned out, it appears that about 6287 lbs. of iodine go to waste annually in this region, worth at present about 22,000 dols., or £4500. It seems very doubtful, however, whether the extraction of this from such a mass of bittern can be made profitable. It might be worth while to try Bechi's plan, liberating the iodine

* *Oil, Paint, and Drug Reporter* of New York, Feb 14, 1877, 10.

Free Acid counted as HCl.		Free Iodine.		Iodine in Iodides.		Total Iodine.	
M.grms. per litre.	Grs. per Im. gal.	M.grms. per litre.	Grs. per Im. gal.	M.grms. per litre.	Grs. per Im. gal.	M.grms. per litre.	Grs. I g.
No. 1—Snow Hill—							
2400	168	59·2	4·14	—	—	59·2	4·14
No. 2—Daniel Boom—							
200	14	1·8	0·13	38·2	2 67	40·0	2·80
No. 3—Newcastle—							
100	7	12·2	0·85	40·0	2·80	52·2	3·65
No. 4—Hartford City—							
400	28	12·4	0·87	26·0	1·82	38·4	2·69

by exactly the right amount of nitrous acid or of chlorine, and collecting it by filtration through animal charcoal. Judging from experiments on the small scale, the precipitation as cuprous iodide seems to be incomplete. The acid condition of these bitterns suggests the probability of extensive loss of iodine by decomposition of magnesium iodide during the later stages of the boiling, and it would be interesting to ascertain what effect upon the amount left in the mother-liquor would be produced by keeping the brine just neutralised with sodium carbonate.

(74.) *Analysis of Epidote from near Greenwood, Albemarle Co., Virginia.* By T. P. Lippit, of Charlestown, West Virginia.

A large lot of railway ballast was laid down some months ago upon the line of the Chesapeake and Ohio Railway, near the University of Virginia, consisting of highly metamorphosed schist passing into felsite, from the above-named locality, and through this epidote was extensively distributed, for the most part intimately mixed with the other components of the rock, but often presenting good specimens in the form of distinct crystalline nodules, sometimes enclosing a nucleus of quartz, and often penetrated by little needles of the same. The mineral is of clear, characteristic, pistachio green colour; sp. gr. =3·39. A careful preliminary examination proved that the iron is altogether in the ferric condition, and that but a trace of alkali is present. After drying at a temperature not over 100° C. analysis gave—

		Atomic Ratios.	
SiO_2	39·74	0·6623	=9
Al_2O_3..	21·55	0·2113	0·3069=4·17
Fe_2O_3	15·29	0·0956	
CaO	22·75	0·4062	0·4214=5·73
MgO	0·61	0·0152	
	99·94		

Agreeing pretty fairly with the normal ortho-silicate formula, $M_6''R_8'''Si_3O_{36}$— about two-thirds aluminium epidote and one-third iron epidote.

(75.) *On the Presence of Ammonia in Human Saliva.* By B. H. Heyward, of Charleston, South Carolina.

A year or two ago I happened to observe the fact that the usual evidence of the presence of ammonia was obtained with human saliva on the addition of the Nessler reagent. So far as I am aware, ammonia has not hitherto been recorded as present in this secretion. Mr. Heyward undertook to examine the point somewhat more fully, and to ascertain whether the reaction is normal by testing the saliva of a number of persons in health, and by examining the secretion of the same person at different times.

In evidence that ammonia is really present, at any rate that the Nessler reaction is not due to any non-volatile or but slightly volatile organic base, a small quantity of saliva was placed at the bottom of a perfectly clean and dry test-tube, a little recently hea ed oxide of magnesium was added, a slip of white filtering paper moistened with the Nessler reagent was suspended in the upper part of the tube, and this was corked and exposed to a temperature of about 30° C. In a few minutes the paper was rendered distinctly orange, while in a blank experiment, conducted under the same conditions, but omitting the saliva, this was not the case.

In all of nineteen different cases examined—all young men in good health—the ammonia reaction was obtained. For ten of these the amount in the mixed saliva was approximately determined by comparison of the colour produced with that due to the use of various determinate dilutions of a very weak standard solution of ammonium chloride. The results were—

1st person, about 100 milligrms. per litre.				
2nd	,,	,,	40 and 80 ditto	(on two occasions).
3rd	,,	,,	80 and 60 ditto	,, ,,
4th	,,	,,	50 and 30 ditto	,, ,,
5th	,,	,,	100 and 50 ditto	,, ,,
6th	,,	,,	60 and 100 ditto	,, ,,
7th	,,	,,	40 and 30 ditto	,, ,,
8th	,,	,,	40 and 30 ditto	,, ,,
9th	,,	,,	50 and 50 ditto	,, ,,
10th	,,	,,	50 and 80 ditto	,, ,,

The mixed saliva of a single person—Mr. Heyward himself—varied as follows on seven successive days :—

1st day—About 40 milligrms. per litre.				
2nd	,,	,,	60	,, ,,
3rd	,,	,,	40	,, ,,
4th	,,	,,	40	,, ,,
5th	,,	,,	40	,, ,,
6th	,,	,,	50	,, ,,
7th	,,	,,	60	,, ,,

To get some idea whether the ammonia is present equally in the pure secretions of the different salivary glands, Mr. Heyward had both of Wharton's ducts closed by a single fine small clamp applied (by Dr. J. S. Davis, Professor of Anatomy in the University) across the frænum of the tongue, and, on examining the saliva collected with the sub-maxillary secretion thus cut off, about 10 m.grms. per litre was the result. Next, these ducts from the sub-maxillary glands were re-opened, and Steno's ducts on both sides were closed by two of the same delicate clamps: with the parotid saliva thus excluded the remaining mixed secretion indicated about 30 m.grms. per litre. The natural saliva on the same morning, none of its components being excluded, showed about 40 m.grms. per litre. Of course the conclusion is that most, if not all, of the ammonia came from the two principal pairs of glands, the parotid and sub-maxillary, and that of these the latter furnished notably the larger share. These results also indicate that the source of ammonia—at any rate the sole or chief source—is not to be found as the free gas in the expired products of respiration, merely condensed in aqueous solution in the mouth.

The main interest attaching to these observations is the establishment of a little point of general physiology; but the practical deduction for chemists may be made, that in delicate analytical determinations with the Nessler reagent a conceivable source of error might arise from small quantities of saliva allowed carelessly to remain upon pipettes or the tubes of washing bottles which have been held in the mouth.

The fact now noted perhaps connects itself with the observation of Schönbein,* that mixed saliva usually, though not always, contains a nitrite or nitrites. Since Mr. Heyward's experiments were made, I have tried the very delicate test of Griess—sulphanilic acid followed by naphthylamin hydrochlorate—upon two or three specimens of saliva, and found the nitrite reaction distinct, although the colour was but slight in each instance.

University of Virginia,
August 20, 1881.

* *Journ. für Prakt. Chemie*, 86, 151.

HYDRATION OF SALTS AND OXIDES.*

By C. F. CROSS.

The hydration of substances, considered as a statical problem, has necessarily received much attention, but its dynamic aspects, especially as presented in the phenomena of dehydration and rehydration, have been very little noticed.

Messrs. Hannay and Ramsay have devised a method for the study of the former, by means of which they obtained a number of interesting and important results (*Chem. Soc. Journ.*, 35, 456 *et seq.*), and in consideration of the value of such constants as they establish, it is to be hoped that they will greatly add to their number. The inverse phenomenon of rehydration must also occupy an important place in future molecular science, and it is with the object of bringing it within the scope of quantitative investigation, of aiding the advance towards a complete knowledge of the relations of matter generally to water, that I have entered upon my researches. The apparatus which I have adopted has been exhibited in a neighbouring building, and sufficiently described in a recent communication to the Chemical News (vol. xliv., p. 101). A number of my numerical results are also expressed in the accompanying diagrams, but my desire, in laying this subject before the Section, is to bring out certain of the more general results of the work already done, and, therefore, with as little reference as possible to particulars. How far the method adopted is to be considered rigorous is the first point for our consideration.

A substance, *e.g.*, $CuSO_4$, with a powerful attraction for water, is exposed under a bell jar to an atmosphere saturated with aqueous vapour. The question that at once arises is this: Seeing that the confined volume of air is very small (2000 c.c.), and the weight of watery *vapour* present also very small in relation to the quantity required by the sulphate (about 1 grm. $CuSO_4$) for saturation, will not the rate of combination of the salt with water rather represent the velocity with which water can be evaporated from below and supplied as vapour than measure the "chemical" attraction of the salt for water? In solution of this, four sets of experiments were made: (1.) It was found that the rate of hydration, *i.e*, the quantities taken up in successive hours and the velocity of attainment of the limiting hydration ($5H_2O$), were strictly proportionate to the ratio of the area over which the salt was distributed to its weight. This held good up to a limit of 1·25 grms. distributed over a circular area of 60 m.m. diameter. With quantities less than this, therefore, copper sulphate does not, in uniting with water, overtake such a supply of water molecules as that conditioned by a volume of 2000 c.c. confined over a surface of water. (2.) A stream of air (*a*), after passing through the water in the trough (*b*), previously saturated by passing over moist cotton-wool, was aspirated through the apparatus by means of a tube passing through the cork of the bell jar; and (*c*), saturated as in the preceding, was aspirated from below, *i.e.*, was caused to descend vertically upon the substance; and in no case was the rate of hydration sensibly affected. (3.) The evaporating surface was several times multiplied by filling the space between the inner glass and the sides of the bell jar with prepared flax, kept moist by capillary absorption of the water in the trough; but the rate of hydration was but very slightly affected. (4.) A large case of glass with a wooden framework, 3 feet in the side, was placed, with its open side downwards, in a trough of water. In this large "bell jar" the salts were confined, by means of an air-tight arrangement: a series of observations showed that the hydration was not sensibly affected by this modification. Within the limits of temperature, therefore, which obtained in the above experiments, 12° to 25° C., we may regard the method of observation as affording strictly accurate results, *i.e.*, in so far as the accuracy desired is of the relative order. And, indeed, an *absolute* measure of the rate of hydration of a salt is in the first instance somewhat difficult of *definition*, and as a quantity to be determined with precision may, without apology, be left to the science of the future.

There occurs in the next place the question of the influence of temperature. This of course is a powerful one, as may be seen from the following table of observations upon $CuSO_4.H_2O$, the quantity of salt being in each case about ½ grm. mol., and the numbers representing the extension of the spirals from the o point.

It is remarkable that the rate of hydration in Expt. 3, *i.e.*, at a temperature below 0° C., is much higher than that which is deducible from the ratio of the tension of aqueous vapour at this, to that at the higher temperatures which obtained in the other experiments, showing consequently that the hydration is by no means a simple function of the number of water molecules in the unit of space.

At a temperature of 50°, in ordinary air, I have observed that the pentahydrated salt loses 4 mols. H_2O, though with such difficulty that it requires 10 to 14 days to complete the dehydration.

Between 0° and 50° on the side of temperature, and complete saturation with and entire absence of water, in respect of the atmosphere surrounding the salt, these varying singly and jointly, we may safely predict the existence of a number of *critical* points for each of these 4 molecules of H_2O. Hence the importance of being able to secure any temperature, and that constant, in all experiments on rehydration. The difficulties to be encountered have hitherto prevented my realising that condition satisfactorily, but the problem will, I hope, be solved before long.

The next question to be dealt with is that of the gain of weight, how far is it due to water only, and how far is it due to water combined with the salt in the manner in which it has been assumed to be? On this latter point

Duration of Exposure.	1.		2.		3.		4.		5.	
	Extension.	Temp. at Time of Observation.	Exten.	Temp.	Exten.	Temp.	Exten.	Temp.	Exten.	Temp.
0 hrs.	88·7	8·5° C.	88·7	8·5° C.	88·7	−1° C.	88·7	16° C.	88·7	25° C.
1	96	8·5	96·0	8·5	92	,,	96	16	99	,,
2	101·5	9·5	102	9·5	94	,,	103	17	107·5	,,
3	106·5	11	106·5	10	—		110	17·5	113	,,
4	109	12·5	112	11	—		113·5	,,	121	25·5
5	114	13·5	114·5	12	—		118	,,	125	26
6	118·5	13	118·5	12	—		122·5	,,	125	26·5
7	120·5	11·5	121	12·5	—		125	,,	125	,,
8	124	11	123	12·5	—		126·5	,,	125	,,
18					118	0				
22					122·5	2				
25					125	2				

* Read before the British Association, York Meeting, Section B.

we have conclusive evidence. Chromium oxide which had been exposed to a saturated atmosphere for 101 days was ignited before and after strong pressure between blotting-paper: in the former case the loss was 60·3 per cent, in the latter 59·82; it contained no precipitated moisture therefore. The sharply "molecular" character of the hydration of copper sulphate, the constancy of the indications of the balances when a limit has been attained, and the microscopic examination of the hydrated salts, all tend to negative the suspicion of the presence of precipitated moisture. Of the probability of the absorption of atmospheric gases, in addition to water, the former objection, there is no need to treat here; it is doubtless considerable as regards relative volume, and has a part to play in affecting hydration, but the former may be neglected as regards weight, and on the latter we can offer nothing but conjecture.

Having subjected the method of investigating this complex problem of rehydration to a critical examination, it remains to bring before you some of the more important facts which it has established.

General Characteristics of the (Re)hydration of Salts.—These have been, so far as the investigation has gone, numerically and diagrammatically represented in the curves accompanying the balances. They present the following features: *Copper Sulphate* combines with decreasing velocity with $5H_2O$, at which point it remains constant for some time; it then proceeds to take up additional water, though with much less velocity, and, in fact, *deliquesces*. This second phenomenon takes many days to complete. Its occurrence, requiring the more "artificial" condition of a saturated atmosphere, has hitherto been overlooked; it is important as showing that from hydration to solution there is an actual and unbroken series of combinations with water. *Sodium Sulphate*, as well as *Potassium* and *Magnesium Sulphates*, pass through hydration to deliquescence without break, and, indeed, any very marked variation in the rate of combination, such as to indicate a distinction between the phenomena. *Potassium Dichromate* gives us a third type of hydration, inasmuch as, under the conditions of exposure described, and also at the ordinary temperature of the air, it "condenses" water to the molecular limit of 3·5 H_2O (becoming $2K_2Cr_2O_7,7H_2O$), none of which water would be said to be combined with the salt, as it is entirely removed by pressure between blotting-paper, or by a short exposure to ordinary air. Precipitated *Ferric Oxide*, dry at 100°, and containing 1 mol. H_2O, hydrates rapidly at first, but after taking up 1 mol. water the combination proceeds very slowly.

In the following table the hydration of this oxide is compared with cupric sulphate ($CuSO_4.H_2O$) under the same conditions:—

Duration of Exposure.	$CuSO_4.H_2O$.		$Fe_2O_3.H_2O$.	
0 hrs.	89		89	
1	96		95	
2	103		96	
3	110		97	
4	113·5		98	$Fe_2O_3.2H_2O$
5	118		99	
6	122·5		101	
7	125	$CuSO_4.5H_2O$	—	
8	126·5		—	
9	127		—	
20	129		106	
26			108	$Fe_2O_3.3H_2O$
74			114	
76			116	
78			116	$Fe_2O_3.4H_2O$
140			119	
203			126	$Fe_2O_3.5H_2O$
260			127	
386			129	

At this point the bell jar was removed and the oxide exposed to the air. The following observations of dehydration were made:—

2 hrs.	109	
3	108	
4	108	
21	108	$Fe_2O_3.3H_2O$

The stability of the trihydrate had been previously observed (*Chem. Soc. Journ.*, 35, 796). The above instances are typical of the entire series of observations, and I do not therefore think it necessary to multiply examples. There are one or two cases in which a remarkable saltus has been observed, but these need confirmation.

In conclusion I take the opportunity of correcting certain statements of previous observers as to the dehydration of copper sulphate, $CuSO_4H_2O$, by absolute alcohol.

Thorpe and Watts state (*Chem. Soc. Journ.*, 37, 103), on the authority of Playfair, that three of the 5 mols. H_2O are eliminated by the action of boiling absolute alcohol. Two preparations which were boiled repeatedly with successive quantities of absolute alcohol I found to contain, after drying over sulphuric acid, 10·9 per cent and 10·6 per cent H_2O respectively, these numbers corresponding to the monohydrate. The necessity of this is an *a fortiori* inference from the observation, previously mentioned, of the elimination of 4 mols. H_2O by prolonged exposure to a temperature of 50° C. In another case, after boiling for 24 hours with repeated change of the alcohol, the product contained only 8·9 per cent, and after a further 16 hours, 7·54 per cent H_2O, which must be taken as tantamount to the complete dehydration of the (whole of the) salt. There are probably many other cases in which the limiting dehydration by means of boiling alcohol has not been attained.

I take this opportunity of thanking Messrs. E. Richards and Geo. Birkbeck, of the Barrow Steel Works Laboratory, for much assistance in carrying out the above experiments.

UPON THE

DIRECT CONVERSION OF THE AROMATIC AMIDES INTO THEIR CORRESPONDING AZO-COMPOUNDS.

By ALBERT R. LEEDS.

I HAVE already published in another place (*Journ. Amer. Chem. Soc.*, 3, 16,) the results obtained by the action of hydrogen peroxide upon benzene. The latter is gradually converted into phenol-oxalic acid, and a small amount of a yellow colouring matter being formed at the same time.

Phenol itself is but slightly acted upon by hydrogen peroxide in the cold, but at the boiling point undergoes conversion into a tarry substance.

Naphthalen, when digested with hydrogen peroxide, yields a small amount of naphthol. Naphthol itself is not affected to any notable extent by hydrogen peroxide in the cold, but at the boiling point is changed to a tar.

When anthracen is dissolved in glacial acetic acid, and the precipitate obtained on the addition of solution of hydrogen peroxide is digested with excess of the latter reagent the anthracen is slowly converted into anthraquinon. Three grms. of anthracen, boiled for three days with hydrogen peroxide, in a flask attached to a return-cooler, were changed almost entirely into anthraquinon, the brown colouring matter formed at the same time being too small in amount to permit of its being experimented upon successfully.

Benzene-sulphonic acid was slightly acted upon, a brown colour being imparted to its solution after boiling for a number of hours with hydrogen peroxide, and the acid crystallising out from the liquid in small colourless crystals,

identical in appearance with the original body before its treatment with peroxide.

The preceding results show that in certain cases hydrogen peroxide operates upon organic bodies by the substitution of hydroxyl; in other cases, by direct oxidation, and in the third place, by both actions combined.

The experiments were therefore extended to the aromatic amides with the hope that hydroxylated derivatives of these compounds might be obtained. The amide was converted into the acetate, or when this not possible, it was dissolved in excess of glacial acetic acid, and a solution of hydrogen peroxide, containing 1·2 per cent of peroxide, added in successive portions. Heating of the liquid had to be avoided, the amide in every instance being changed to a tarry substance. This result indeed happened in most instances, even when the experiment was conducted at common temperatures or with gentle warming. The following is a brief summary of the results obtained with the compounds thus far operated upon:—

Diphenylamin yielded a large amount of a black liquid and a black tar.

Dimethylanilin gave a very dark red liquid with a black residue soluble in alcohol.

Xylidin formed a claret-coloured liquid with a blackish residue dissolving in alcohol to a dark purple solution.

Naphthylamin gave a rose-coloured liquid with a brownish-black residue.

Similar results were obtained with orthotoluidine, the solution acquiring a ruby colour, and a blackish tarry residue soluble in alcohol being formed.

Failing to obtain by careful sublimation, or by treatment with ligroine, alcohol, and other solvents, any crystalline bodies from the above products, their further study was abandoned.

Aniline and paratoluidine acted differently. The solutions of their acetates in hydrogen peroxide quickly threw down, on gentle warming, copious precipitates of a brownish crystalline appearance. At higher temperatures there was a formation of tar. The precipitates came down principally on the first treatment with the peroxide. On filtering them off and adding an amount of the peroxide in excess of the calculated quantity, the second crop of crystals was small, and the larger portion of the aniline or paratoluidine acetate remained behind in the solution.

The precipitates, after washing and drying, were sublimed very slowly, since the small amounts of accompanying tarry matter interfered seriously with the operation when the temperature was not carefully regulated at the lowest practicable point. The sublimate from the paratoluidine formed yellow needles, some of them exceeding two inches in length. They were repeatedly crystallised from alcohol, in which they are not very readily soluble, and were finally obtained as magnificent orange needles. Their melting-point was 143-144°.

0·2806 grm. of the substance yielded on combustion 0·8123 grm. carbonic acid and 0·1763 grm. of water. These results agree with those calculated on the supposition that the body is azotoluol, $C_{14}H_{14}N_2$:—

	Calculated.	Found.
Carbon	80·00	79·28
Hydrogen	6·66	6·98
Nitrogen	13·34	13·51

The same body has recently been obtained by Barsilowsky* by the action of very dilute potassium permanganate solution upon toluidine sulphate. This reaction yielded a very small product, and Barsilowsky afterwards used a solution of potassium ferricyanide and caustic potash with better results. The orange crystals thus obtained melted at 144°, and were identical in their physical properties both with the parazotoluene, derived by Petrieff from the reduction of nitrotoluene, and with the substance described by the author. By the action of hydrogen peroxide, therefore, upon paratoluidine it is converted directly into parazotoluene.

* *Ann. der Chem.*, 207, 102.

The sublimate from the aniline product yielded large red crystals, together with some accompanying yellow oil. This sublimate had a melting-point of 66°, showing that the body was azotoluene (m.-pt., 66·5°).—*Journal of the American Chemical Society.*

ON CRYSTALS PRODUCED BY THE ACTION OF METALS SEALED UP IN CARBON DISULPHIDE.*

By PHILIP BRAHAM, F.C.S.

FIFTEEN different metals were sealed up in carbon disulphide on June 20, 1879. The tubes were carefully examined from time to time under the microscope. On June 20, 1880, appearances of incessant crystallisation were observed. On May 20, 1881, transparent crystals were found in those tubes which contained gold, antimony, and bismuth. The experiment is being continued.

A new micro-goniometer was exhibited.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 4, 1881.

J. P. JOULE, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

"*On Drops Floating on the Surface of Water*," by Professor OSBORNE REYNOLDS, F.R.S.

It is well known that under certain circumstances drops of water may be seen floating on the surface for some seconds before they disappear. Sometimes during a shower of rain these drops are seen on the surface of a pond; they are also often seen at the bows of a boat when travelling sufficiently fast to throw up a spray. Attempts have been made to explain this phenomenon, but I am not aware of any experiments to determine the circumstances under which these drops are suspended. Having been deeply engaged in the experimental study of the phenomena of the surface tension of water and the effect of the scum formed by oil or other substances, it occurred to me that the comparative rarity of these floating drops would be explained if it could be shown that they required a pure surface, a surface free from scum of any kind. For, owing to the high surface tension of pure water, its surface is rarely free from scum. The surface of stagnant water is practically never free except when the scum is driven off by wind. But almost any disturbance in the water, such as the motion of the point of a stick round and round in the water, or water splashed on the surface, will serve to drive back the scum for a certain distance. This may be shown by scattering some flowers of sulphur on the surface. This powder is insoluble and produces no scum, and hence it serves admirably to show the motion of the surface and whatever scum there may be upon it. If, when the surface is so dusted a splash be made by a stick so as to throw drops on to the sulphured surface, at the first splash no floating drops are produced; but after two or three splashes in rapid succession it will be seen that the sulphured scum has been driven back by the falling water, leaving a patch of clear surface, and on this drops will float in large numbers and of all sizes. These drops are entirely confined to that portion of the surface which is clear. The drops, either by their initial motion or by

* Read before the British Association, York Meeting, Section B.

the current of air, glide rapidly over the surface from the point at which they are formed. When, however, they reach the edge of the scum they disappear, apparently somewhat gradually. I have this summer made the experiment on several ponds and on various days, and I have never found any difference. Any scum, however transparent, prevented the drops, and they always floated in large numbers when the scum was driven back in the manner described, by the wind or any other way.

This result points to the conclusion that whatever may be the cause of this suspension, it depends only on the surface of the water being pure, and not at all on the temperature or condition of the air.

"*On the Mean Intensity of Light that has passed through Absorbing Media*," by James Bottomley, D.Sc., F.C.S.

"*Note on the Colour Relations of Nickel, Cobalt, and Copper*," by James Bottomley, D.Sc., F.C.S.

In a paper read before the Physical and Mathematical Section, April 13th, 1880, I referred to some experiments I had made to obtain a soluble black, and showed the advantages of such a solution in photometry, also its application to the determination of the law of absorption of light. The mixture used consisted of nickel, cobalt, and copper sulphates in acidulated water. In a paper read before the Chemical Society, May 19th, 1881, Mr. Thomas Bayley gives the results of some similar investigations. He also finds a mixture of nickel, cobalt, and copper sulphate suitable. The proportions of the metals in his solutions are:

Co.	Ni.	Cu.
1	1·48	2·16

The quantities of the salts used in the preparation of the fluid referred to in my paper give the following ratios between the metals:

Co.	Ni.	Cu.
1	1·49	2·46

NOTICES OF BOOKS.

A Pocket-book for Chemists, Chemical Manufacturers, Metallurgists, Dyers, Distillers, Brewers, Sugar Refiners, Photographers, Students, &c. By Thomas Bayley, Assoc. R.C.Sc.I. Second edition, with additions. London: E. and F. N. Spon.

We are not surprised that a second edition of this invaluable *vade mecum* has been called for. If we point out anything which to us seems a sin of omission or of commission, we do so not with the desire to find fault, but in accordance with the concluding paragraph in the preface. It seems to us that the "distillers, brewers, and sugar refiners," get a rather too preponderating share of space, *i.e.*, one-sixth part of the whole volume, or nearly three times as much as is bestowed upon all the other chemical arts and manufactures taken collectively.

The rule given for the respective conversion of Fahrenheit into Centigrade, and *vice versa*, is applicable only for temperatures above freezing-point. For degrees between 32° and 0° F., and for those below 0° F., two further rules are required. The "Polar" system of weights and measures seems to have certain advantages over the metric system.

Agricultural chemistry has received here little attention. Tables for the rapid valuation of manures would be useful to many, and so would notes on the weights, absorbent powers, &c., of different classes of soils, and on the average composition and value of the raw materials used in manure making. In like manner metallurgy and the tinctorial arts fare but scantily. The price list of apparatus is scarcely necessary; the same may be said of the wages table, and of the ready reckoner. On the other hand, tables showing the value of metric weights, from a gramme upwards in English ounces and pounds, and a similar table for converting cubic centimetres and litres into fluid ounces and pints would have been very valuable to, *e.g.*, dyers, who often meet with French or German recipes.

What to do in Cases of Poisoning. By W. Murrell, M.D., M.R.C.P., &c. London: H. K. Lewis.

We have here a useful little manual for the faculty. The suggestion of an antidote bag fitted with the appliances and drugs needed in poisoning cases is exceedingly judicious, and may often save precious time, which here is everything. After some general remarks on the use of the stomach-pump and on the selection of emetics, the author gives an alphabetical list of poisons, with the treatment to be adopted in each case. Here we note certain omissions. There is no mention of aniline, which, now it has become an article of commerce, may occasionally give rise to accidents. Three native poisonous plants are also overlooked, mezereon, bryony, and arum.

Concerning the directions for snake bites, we entertain some misgivings. It is said "the wound should be thoroughly washed and sucked." But the poison of the more deadly serpents, such as the cobra, appears capable of causing alarming symptoms if taken internally, so that sucking might prove a dangerous proceeding. We also find the remark that "bleeding followed by transfusion might in some cases prove of avail." From the form in which this advice is given we should doubt whether the author can produce an instance of its having been tried with success. The *rationale* of bleeding in such a case might be thus stated: Here is a polluted river; to purify it, remove a portion of the water!

In the instructions for a compound case of poisoning with opium and chloral we find an error, clerical or typographical, which may be perplexing. The passage reads: "Should the symptoms of strychnia poisoning predominate give a hypodermic injection of gr. 1-80 of sulphate of strychnia."

We are glad to see that Dr. Murrell points out the danger of administering oil in certain cases (cantharides and phosphorus), especially as a paragraph has been widely circulated in the lay press recommending large doses of oil as an antidote for all poisons. We note a few typographical errors, such as "apomorphic" for "apomorphia," "phosphorous" for "phosphorus," &c. The author has not adopted the newest chemical terminology, and, in despite of South Kensington, makes the organic bases end in *ia* instead of *ine*, and writes, *e.g.*, "sulphate of magnesia," instead of the orthodox "magnesium sulphate."

Inorganic Chemistry, Theoretical and Practical. An Elementary Text-book designed primarily for Students of Science Classes connected with the Science and Art Department of the Committee of Council on Education. By W. Jago, F.C.S., &c. London: Longmans and Co.

Practical Chemistry. Adapted to the First Stage of the Revised Syllabus of the Science and Art Department. By J. Howard, F.C.S., &c. London and Glasgow: W. Collins, Sons, and Co., Limited.

We have here two more elementary treatises on chemistry, one of them a new work and the other a new edition. Both are written under the haunting presence of the Science and Art Department and with reference to examinations. Each goes over substantially the same ground; each contains, as appendix, a selection of questions taken from former examination-papers. Mr. Jago has an admirable preface, in which he explains the unfortunate predicament in which teachers of science find themselves placed by the examination-mania and its promoters. We only hope that his plain speaking may not be avenged upon his pupils.

Mr. Howard, who, in his former editions, used the Kensingtonian notation only, has now given in addition the notation and formulæ used by Professors Williamson and Thorpe.

CORRESPONDENCE.

ASSAY OF CUPRIFEROUS BLENDE.

To the Editor of the Chemical News.

Sir,—Well knowing the amount of trouble and annoyance caused to assayers and analysts, in the assay of cupriferous blendes, by the different methods in use for disposing of the copper, and also the frequent disagreement in results, I have great pleasure in sending you for publication in your Journal a method which is as rapid as it is accurate, the only part which is original being the simple and effective way of disposing of the copper. It is as follows:—

½ grm. of the blende is taken and treated with aqua regia and evaporated: it is re-moistened with hydrochloric acid, and re-evaporated, dissolved in water with a drop or two HCl, 10 to 20 c.c. of ammonia added, and the iron filtered off and washed.

The filtrate, which is now about 200 to 250 c.c. in volume is acidified with HCl, heated and placed in a porcelain dish ready for buretting with ferrocyanide of 0·01 strength. To the solution of zinc and copper I add sodic sulphide solution enough to precipitate the whole of the copper and leaving a little excess, then proceed with the buretting with ferrocyanide and uranium acetate as indicator.

In some experiments which I made I took a non-cupriferous blende and weighed out six samples into three, of which I put some sulphate of copper solution equal to 2½ per cent copper in the blende, and proceeded with them as above explained, and obtained perfectly concordant results.—I am, &c.,

R. Monger.

Laboratory, Middle and Upper Bank Copper Works,
Swansea, October 17, 1881.

AFFINITY AND VALENCY.

To the Editor of the Chemical News.

Sir,—Mr. Brown has attempted to deal with a vast subject within very narrow limits, and in offering certain criticisms of his conclusions I shall endeavour to follow his example. Chemical and Human Philosophy present an interesting parallelism, which is in no point more conspicuous than in the greater conflicts which are waged in either department of scientific investigation. In the latter the individual and his will are to one school the essential phenomena of life, while another section of thinkers impressed with the majesty of "law," and the stupendous movements of Nature, are somewhat impatient of their trivial incidents, and so refuse them objective reality. Since the days when Berthollet opposed the "special" interpretations of chemical reactions with his transcendental theory of Chemical Statics, to the time when Berthelot and Thomson would make our science tributary to the greater philosophy of Energy, there has not been wanting a well-organised opposition of those who are inclined to give more weight to the individual characteristics of the elements as the essential cause of chemical reactions. The controversy having reached the citadel, and Mr. Brown being persuaded that the concurrence of representative opinion expressed at the York Meeting of the British Association has assigned to Valency a position in which it ceases as a conditional phenomenon to have much substantive value, we have to enquire whether he is justified by his arguments in forsaking what *has been* a stronghold of chemical thought, before the "Cosmopolitans" have actually taken possession?

In the first place his main argument suffers from a strange confusion of the terms "Chemical Energy" and "Affinity," and from the general looseness of his opening sentence: "It is generally supposed that (in combining) the chemical energy or affinity of the atoms is *neutralised*, such neutralisation . . . similar to that which takes place when a conductor charged with + E . . . with another which has received a negative charge." It surely was not necessary for the success of the doctrine which Mr. Brown would expound to begin by tilting with a "man of straw." The ordinary "supposition" would, I think, be that the chemical energy of the atoms in combination is less than in the uncombined state, by the work done during the change of state; as regards the matter which has taken part in the reaction that it is unchanged in every respect; lastly, as regards the special property of affinity, that, to retain Mr. Brown's illustration, molecules of HCl, presented to further molecules of H, would suffer no disturbance, because the affinities of the H and Cl atoms each with each is satisfied. The reasoning by which the straw man is ventilated is still more extraordinary. "The molecule H_2 is supposed . . . two atoms of hydrogen united together by the force of chemical affinity precisely as a H atom is united to a Cl atom in HCl. Now if neutralisation takes place . . . it must be complete, *for they are identical*. . . . &c."

The only excuse for this poor logic is in the confusion of terms alluded to, which has propagated itself to the two expressions, "precisely in the same manner" (stated), and "precisely in the same degree" (implied). Let me use an illustration: a cube of lead above the surface of the earth will attract a second cube of lead, which is in contact with it, but will this affect the work done by the fall of each to the ground? This is the parallel that would suggest itself to most minds as fairly complete, and is a sufficient justification of the "ordinary" supposition. Mr. Brown next wishes to show "that the atoms of hydrogen and oxygen which form the molecule (of water) retain their original attraction when thus combined together." And having shown it to his satisfaction by discussing the three alternative hypotheses, he generalises the proof, and closes his case by an inconsequent adaptation of these arguments to the "reasonable" ascription of "the phenomena of valency to the conditions of space and motion under which the atoms are placed." Mr. Brown will perhaps re-state his case for the Transcendental School unless he deems these objections trivial. Until he does I do not feel justified in trespassing farther upon your space in the discussion of a problem which I confess, without the fear of being accused of modesty, is considerably beyond me.

The italics throughout the above are mine.—I am, &c.,

C. F. C.

A NEW FORM OF WASH-BOTTLE.

To the Editor of the Chemical News.

Sir,—Some few months ago I devised a form of wash-bottle which I have found to be very effective, and as it is also very easily made I have thought it worth while to make it known to a wide circle.

The improvement consists in a modification in the form of the blowing-tube, by means of which a continuous jet of water can be obtained for some time after ceasing to blow, and steam and badly-smelling vapours are prevented from entering the mouth.

The blowing-tube is made as follows:—Bend a piece of glass tubing to form the same angle as that of the blowing-tube of an ordinary wash-bottle, then bend one end completely round in a plane at right angles to the plane of the angle previously made, and break off the straight portion of the tube a little way from the bend. Now bend another piece of tubing completely round, and

break off one of the arms very near the bend. This last made tube is then put through its hole in the cork of the bottle, and joined by a short piece of india-rubber tubing to the shorter limb of the other tube. The two tubes thus joined are tied together at the top by a piece of string. The cork of the bottle should project some little way in order that the india-rubber tube may be closed at will by pressing it with the thumb against the side of the cork.

When washing with boiling water, &c., close the india-rubber tube with the thumb before commencing to blow, and before ceasing close it again in order to prevent steam from getting into the mouth, and also to get a continuous jet.—I am, &c.,

A. E. Johnson.

St. George's Hospital, S.W.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 12, September 19, 1881.

Relative Resistances which should be given in Dynamo-electric Machines to the Active Coils, to the Inductor Electro-magnets, and to the Interior Circuit.—Sir W. Thomson.—This memoir has appeared also in English.

Experiments made in 1826 on the Electric Currents produced by Lightning far from the Place of Observation, and the Recent Studies of M. René Thury on the Sounds of Telephones during Storms.—D. Colladon.—M. R. Thury has stretched a copper wire horizontally between two houses at the height of the roofs, and connected with the earth by means of water-pipes. To this wire was joined a telephone, whose resistance measured 4·5 ohms, and another similar apparatus of 25 ohms. On occasion of every storm, near or remote, the flashes of lightning have been accompanied by a very characteristic sound perceived in the telephones, at the same instant when the lightning was seen, at whatever distance, and resulting consequently from the inductive action of the discharge upon the wire. These telephonic experiments offer a very easy method for studying the induction effects produced by these lightnings, and of measuring the speed of transmission of these influences, even to great distances.

Measurement of the Rotation of the Plane of Polarisation of Light under the Magnetic Influence of the Earth.—Henri Becquerel.—It results from the author's experiments that the yellow rays D, traversing a column of 1 metre of carbon disulphide at 0°, under the influence of terrestrial magnetism, at Paris, and in a direction parallel to the dipping needle, experience a simple magnetic rotation of 0·8697′ from the right to the left, for an observer supposed to be laid horizontally with his head towards the magnetic north.

New Sulphur Salts produced with Phosphorus Sesqui-sulphide.—G. Lemoine.—The author has discovered a new series of salts, the sulphoxy-phosphites, that is, phosphites where 2 atoms of oxygen are replaced by 2 atoms of sulphur. They recall the sulphoxy-arseniates of MM. Cloëz and Bouquet, and the sulphoxy-phosphates of M. Würtz. In addition, certain of these salts contain sulphuretted hydrogen, which takes the place of the water of crystallisation, and even the constitutional water necessary to the existence of the phosphites.

Tungsto-boric Acid and its Salts.—D. Klein.—The author describes the tungsto-boric acid and its barium, mono- and di-sodium, potassium, ammonium, magnesium, aluminium, chromium, manganese, cadmium, nickel, cobalt, uranium, copper, zinc, lead, thallium, silver, cerium, and mercury salts.

Determination of Phosphoric Acid by Standard Solutions.—E. Perrot.—The author's process is based on the precipitability of calcium phosphates by ammonia; the solubility of calcium and magnesium phosphates in acetic acid, and the insolubility of iron and aluminium phosphates in this reagent; and on the power of the soluble phosphates, acid or basic, to precipitate salts of silver as a yellow tribasic silver phosphate, insoluble except in ammonia. He dissolves 6·895 grms. pure silver nitrate in distilled water, and makes up to 1000 c.c.; this corresponds to 4·565 grms. metallic silver per litre; 100 c.c. of this solution precipitate 0·710 grm. phosphoric acid. He dissolves 5·414 grms. sodium chloride in distilled water, and makes up to 2000 c.c.; 100 c.c. of this solution precipitate 0·500 of silver. He dissolves the phosphatic matter in nitric acid of sp. gr. 1·030. The solution is filtered and the insoluble part washed with hot distilled water; the washings are added to the acid liquid, which is super-saturated with ammonia. The precipitate is washed with ammonia water upon a small filter, and it is then dissolved upon the filter (changing the recipient) by sprinkling it with acetic acid. The calcium and magnesium phosphates alone are dissolved. The liquid is mixed with ammonia till a precipitate begins to appear, which no longer dissolves on shaking. This precipitate is made to appear by the addition of a drop of acetic acid. This liquid should be collected in a stoppered bottle, holding 250 c.c. There are then added by means of a graduated pipette, 100 c.c. of the standard silver solution. On agitation the characteristic yellow precipitate of silver phosphate appears. When it has settled, the excess of silver remaining in the liquid is determined by running in the salt solution from a graduated burette.

No. 13, September 26, 1881.

Researches on the Gymnotus conducted by the Late Dr. Sachs.—M. du Bois-Reymond.—The author, in conjunction with Dr. Fritsch, has edited the hitherto unpublished researches of Dr. Sachs on the Gymnotus.

Photometric Comparison of Sources of Light of Different Colours.—A. Crova.—The author uses a spectro-photometer. If we illuminate the semi-discs of the screen of a Foucault's photometer with an electric light and with a standard Carcel lamp, and bring the two illuminated spots to touch each other, it is very difficult to judge of the equality of the illumination, as one of the halves has a bluish tint in comparison with the other, which appears to be of a yellow-orange, and the lamp may be moved within very wide limits without the eye being able to judge if an equality of illumination has been really obtained. But if whilst looking at the screen we place before the eye two Nicol prisms, the right sections of which are rectangular, and between which is placed a plate of quartz perpendicular to the axis and of 9 m.m. in thickness, the two fields then appear of a whitish green colour, and if the distance of the standard lamp is varied there comes a moment when equality of intensity is obtained, and the boundary line between the two fields disappears. A very small movement of the lamp suffices then to show a distinct contrast between the two spots.

Studies on the Chemical Action of Light.—G. Lemoine.—It is known that in sulphur and phosphorus, light produces the same isomeric transformations as heat. The case is the same with styrolene, which is converted into meta-styrolene by prolonged exposure to the sun. Bodies in solution are not always affected in the same manner by light as when solid. Silver chloride is not affected by light when dissolved in ammonia. The action of light upon various bodies, such as chromic acid, silver oxide, mercuric oxide, gold chloride, &c., depends to a very great extent on the presence of traces of organic dust. The red end of the spectrum is much less efficacious than

the violet end, though in most cases if the action is sufficiently prolonged the same result is ultimately obtained.

Researches on Tropine.—M. Ladenburg.—Not suitable for abstraction.

A Ureometer.—M. de Thierry.—The author has laid before the Academy an instrument for determining the urea in urine. The author's process is based on the known decomposition of urea by sodium hypobromite.

Journal de Pharmacie et de Chimie.
June, 1881.

The Peptons.—A. Petit.—This paper is medical rather than chemical in its tendencies.

A Rapid Process for the Determination of Uric Acid.—A. Petit.—By operating as follows the author effects the determination of uric acid in two hours:—200 c.c. of filtered urine are mixed with 5 c.c. of fuming hydrochloric acid, and the mixture is beaten up for five minutes in a beaker, care being taken not to scratch the glass. The liquid, which is clear at first, becomes turbid and deposits the uric acid in the form of very small crystals. It is let stand for an hour in a cool place, and filtered through a double filter previously tared. Paper which filters quickly must be selected. The filters are then washed with alcohol, dried at 100°, and the difference of weight between the two, multiplied by 5, gives the proportion of uric acid in a litre of urine.

A Reagent for Distinguishing the Ptomaines from the Vegetable Alkaloids.—P. Brouardel and E. Boutmy.—Already noticed.

Apparatus for the Treatment of Metallic Sulphides with Bromine.—E. Reichardt.—This paper requires the accompanying illustration.

Studies on the Kernel of the Date.—M. Georges.—This kernel can only furnish a very poor article of diet. The absence of starch and the small proportion of albuminous matters do not allow it to be classed with any of the ordinary nutritive matters.

July, 1881.

Atropine.—J. Regnauld and F. Valmont.—The principal conclusions of the authors are:—The atropine of medicine is a mixture in variable proportions of two isomeric crystalline alkaloids, possessing the same therapeutic properties. One of these is atropine-α (atropine of Ladenburg); the other is atropine-β, or preferably atropidine (hyoscyamine of Ladenburg). Atropidine exists in such abundance in belladonna that it forms about two-thirds of the crystalline atropine of the codex. It is the crystalline alkaloid of all the mydriatic Solanaceæ and of Duboisia, and has been improperly named datu ine and duboisine.

Researches on the Formic Ethers.—MM. Berthelot and Ogier.—Already noticed.

Artificial Production of Vivianite.—J. Girardin.—Hydrated ferric phosphate is produced by incinerating bone-black which has been previously used in the decolouration of beet-root sugar.

Complex Function and the Constitution of Morphine.—P. Chastaing.—The author concludes that morphine is a phenol.

Assimilation of Nitrogen by Plants.—M. Lamatina.—The author is of opinion that plants require to assimilate nitrogen in three states: In the nitrates occurring in the soil, in the ammonia of the atmosphere, and in the protoxide of the atmosphere. The nitrogen in the state of nitrate absorbed by the roots is destined for the transportation and diffusion of the mineral substances, and especially of potash in the leaves. The nitrogen absorbed as ammonia by respiration serves for the formation of the albumenoids. The nitrogen absorbed as protoxide serves as the complement of the nourishment of the plant, acting as a corrective by neutralising the excess of the bases, and concurring in the formation of the alkaloids.

Bulletin de la Société Chimique de Paris.
No. 11, June 5, 1881.

Separation of Zinc from Cadmium and the Determination of the Latter.—M. Kupfferschlæger.—A complete separation can be effected in a few hours by simply plunging a slip of bright zinc into the mixed solution in a test-tube, and leaving it there till all apparent action has ceased, decanting the liquid, washing the deposit of cadmium first with boiled water and then with alcohol, drying with exclusion of air, and weighing. The author operates on a neutral solution of the sulphates, previously heated to expel the air. The test-tube is loosely stoppered.

Quick Process Employed in the Municipal Laboratory for the Determination of Lead in Samples of Tin.—M. Roux.—The alloy is laminated, and 2·5 grms. are dissolved in 15 c.c. nitric acid in a flask marked at 250 c.c. The nitrous vapours are expelled by boiling, and after 40 c.c. of a saturated solution of sodium acetate have been added, it is diluted to 250 c.c., and the stannic acid is allowed to deposit. Of the clear supernatant liquid 100 c.c. are taken, corresponding to 1 grm. alloy, and there are introduced into it 10 c.c. of a titrated solution of potassium bichromate containing 7·13 grms. per litre, and of which 1 c.c. throws down 1 centigrm. of lead. After the chromate of lead has been deposited, 10 c.c. more are added, and so on till the liquid is coloured yellow by the excess of bichromate. The liquid is filtered, the precipitate washed, and the excess of bichromate determined by means of a solution containing per litre 57 grms. double sulphate of iron and ammonium and 25 grms. sulphuric acid. This liquid is preserved in a sort of washing bottle under a layer of petroleum or benzol. Nevertheless its standard must be frequently verified. To ascertain the excess of bichromate employed spots are made upon a white porcelain plate with a very dilute solution of potassium ferricyanide preserved in a black bottle. As long as there is not an excess of ferrous oxide in the liquid, the spots retain their reddish yellow colour, but as soon as the bichromate is completely reduced the spots take a tint, green at first and then blue. If lead is precipitated in presence of stannic acid, there occurs an error of about 2 per cent, in consequence of the potassium bichromate mechanically entangled in the precipitate. If the liquid does not appear red after titration with iron, enough sodium acetate has not been added.

No. 2, July 20, 1881.

Formation-heat of Various Organic Compounds.—MM. Berthelot and Ogier.

Thermic Formation of Pyrogenous Carbides.—M. Berthelot.

Remarks on the Characters of Organic Chlorinised Gases and Vapours.—M. Berthelot.

Ethyl Peroxide.—M. Berthelot.—These four papers have been already noticed.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 6, June 9, 1881.

The French Association for the Advancement of Science will meet next year at La Rochelle.

The Methanometer.—D. Monnier.—This instrument is an automatic indicator of the presence of "fire-damp." This gas, in contact with an excess of air and under the influence of the induction-spark or a red-hot platinum wire, is decomposed into naphthalin, carbonic acid, and water. From this decomposition there results a depression which is transmitted in Monnier's apparatus to a manometer, the mercury of which on reaching a certain level sets up an electric current.

No. 7, June 16, 1881.

The telegraphic communication between Souk-el-Arba and Medjez-el-Bab being interrupted, it was found that an enormous serpent had coiled itself around the wire and a post, thus interfering with the conductivity of the line.

Influence of the Contact of Air upon Fermentation.—The conclusion drawn is that in cases where it is desired to effect a very rapid fermentation, access of air is indicated. If, on the contrary, a slower fermentation is desired and a greater development of cellules, the influx of air should be reduced.

No. 8, June 23, 1881.

The alcoholometer of Gay-Lussac has been officially recognised in France as obligatory both in administrative and in private affairs.

M. de Rossi concludes that explosions of fire-damp are always preceded by slight microseismic undulations and sounds, too feeble to be detected by the ear. He proposes the establishment in the neighbourhood of coal-mines of stations fitted up with microseismographs and microphones so as to detect the approach of danger.

The duplex telegraph of the Marquis Tommasi is said to have been successfully tried on the line from Paris to Mantes.

Spectroscopic Researches.—G. L. Ciamician.—The author describes the spectrum of carbon and cyanogen, which seems composed of two parts, one of which resembles that of nitrogen. He indicates a spectrum of the second order for boron. He groups the elements as follows:—

B, Al, C, Si,	N, P, As, Sb,	O, S, Se, Fe,
Fl, Cl, Br, I,	Na, K, Rb, Cs,	Mg, Ca, Sr, Ba,

and admits that in each group the elements are formed of a fundamental matter and of several atoms of oxygen. The atomic weights calculated according to this rule differ notably from those obtained by experiment.

Nos. 9 and 10, June 30 and July 7, 1881.

These numbers contain no original chemical memoirs.

No. 11, July 14, 1881.

Means of Detecting the Sophistications of Olive Oil with other Oils.—The oils employed at Marseille for the adulteration of olive oil are the oils of colza, sesame, cotton, and earth-nuts. Colza oil is detected by means of the sulphur which it contains; 10 grms. of the sample are saponified in a glass capsule with an alcoholic solution of caustic alkali free from sulphides. The mixture is stirred with a silver spoon, and if this is blackened, colza, or at least some cruciferous, oil is present. For the detection of the oil of sesame a little sugar is added to hydrochloric acid at 30° (Baumé ?), which is then mixed with an equal bulk of the oil in question. The mixture is well shaken up, and the least traces of oil of sesame are indicated by a red colouration. For the detection of cotton-seed oil there is added to the sample an equal volume of nitric acid at 40°. On stirring the mixture takes a coffee colour. The detection of oil of earth-nuts is less simple. The sample is saponified with an alcoholic solution of potash, the soap separated as completely as possible, heated to expel the alcohol, and treated with enough hydrochloric acid to neutralise the alkali. The supernatant fatty acid—arachidic acid—is collected and dissolved in boiling alcohol, from which it separates in a characteristic white nacreous form.

No. 12, July 21, 1881.

The company by which *Les Mondes* is published was declared dissolved on July 16th. The journal will, however, continue to appear.

Aniline hydrochlorate dissolved in water in the proportion of ½ kilo. per hectolitre, is used for the destruction of the asparagus beetle (*Crioceris asparagi*).

The Cyclides and the Encyclides.—Dr. C. Brame.—This memoir requires the accompanying illustrations.

The Editor expresses the opinion that the Faure accumulator does not solve the question of domestic electric lighting.

The "crackling" of tin is not peculiar to this metal, but may be recognised in other metals when in a semi-crystalline state.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., No. 91.

On Hydrocellulose.—M. Aimé Girard.—The author has established some years ago that cellulosic matter, in whatever form, if submitted to the action of acids under determined conditions, passes before saccharification into an intermediate state of hydration. The cellulose then loses its normal cohesion, and becomes absolutely brittle. In this state the author names it hydrocellulose. It retains, however, the chemical properties of normal cellulose, and especially that of forming nitro-compounds, which are excessively friable. If such nitro-compounds are prepared with cold and concentrated acids they are explosive; with hot and dilute acid they are soluble in mixtures of alcohol and ether, and are suitable for the manufacture of photographic collodion.

Gas and Electricity considered as Thermic Agents.—Dr. W. Siemens.—A lecture delivered at Glasgow.

On Electric Lighting (the Brush System).—An extensively illustrated paper.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chromate of Iron.—Can anyone inform me as to the following in relation to chromate of iron used generally for the manufacture of chromate or bichromate of potassium, &c. At what price could such chromate of iron, containing from 50 to 51 per cent of oxide, find a ready sale in England? What quantities would be readily taken up on the market? Would it be difficult to find purchasers? It is understood that the chromate of iron now consumed in England comes from Turkey, from a property belonging to the Sultan's mother. Is that so?—W. L. W.

Arsenic in Iron Pyrites.—The statements on this subject are so various and conflicting that I should feel much indebted to any chemist who has worked on it for reliable information as to amount in any ores. The percentage being generally small, probably under 1 per cent in such ores as the Spanish and under 0·5 per cent in some from other places, it is by no means easy to estimate the arsenic, or in many cases even to detect it, when practical working shows it to be present. Can anyone who has had experience point out the best methods for qualitative or quantitative analysis, or inform me where such are described? Various plans, both qualitatively and quantitatively, have been tried in my laboratory, and I should have pleasure in giving anyone interested information about them.—H. B. Gibbins, Neath.

MEETINGS FOR THE WEEK.

Thursday, 3rd.—Chemical, 8. "On Citraconic and Mesaconic Ethers and Malic and Fumaric Acids," by W. H. Perkin. "On the Action of Potassium Cyanide on Bismuthous Nitrate;" "On the Atomic Weight of Bismuth" (Preliminary); "Note on the Action of Sulphuric Acid on Zinc and Tin;" "Note on the Influence of Water on the Reaction between Potassium Iodide and Chlorine;" "The Volumetric Determination of Bismuth in the Form of Oxalate;" "Additional Observations on the Halogen Salts of Bismuth:" "Laboratory Notes (*a*. A Lecture Experiment; *b*. Dissolution of Manganic Dioxide and Manganese Ores in Hydrochloric Acid; *c*. A New Method of Detecting Tin in Presence of Antimony; *d*. Detection of the Haloid Acid in Presence of Nitrous and Nitric Acid)," by M. M. Pattison Muir.

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1145.

ALTERATIONS IN THE PROPERTIES OF THE NITRIC FERMENT BY CULTIVATION.*

By R. WARINGTON.

The earlier researches on nitrification conducted in the Rothamsted Laboratory have been already communicated to the Chemical Society. In the second communication (*Trans. Chem. Soc.*, 1879) some experiments were described (Sixth series), in which a solution of chloride of ammonium, containing the usual nutritive ingredients, was seeded from an old solution which had some months before undergone a nitric fermentation; the result of this seeding was a purely nitrous fermentation, no nitric acid apparently being produced. Experiments have since been made on the conditions which respectively determine the formation of nitric and nitrous acid: a preliminary notice of the results is now communicated.

When a small quantity of fresh soil is employed to seed solutions of chloride of ammonium supplied with nutritive ingredients, a pure, or nearly pure, nitric fermentation is obtained if the solution is sufficiently shallow and dilute, and the temperature low; this is the case, for instance, when 80 milligrms. of chloride of ammonium are present in 1 litre, the column of the liquid 4 or 5 inches in depth, and the temperature about 15°. Under such circumstances only a trace of nitrous acid is formed, and this changes into nitric acid before the conclusion of the action. If the solutions employed are much more concentrated, or the temperature is considerably raised, large quantities of nitrous acid are produced. This formation of nitrous acid may be avoided to a great extent by diminishing the depth of the solution, but at the temperature of 30° it is very difficult to avoid the formation of considerable quantities of nitrous acid, even with small depths of solution. In all cases in which soil has been used as seed the nitrous acid formed exists only temporarily in the solution, the final product of the fermentation being always nitric acid.

Soil added to a solution of nitrite of potassium, supplied with nutritive ingredients, readily converts the nitrite into nitrate.

When solutions, which have been seeded with soil and undergone the nitric fermentation, are themselves employed as seed for new solutions of ammonia, the final result as before is nitric acid; but this is apparently true only when the solution used as seed is not at most more than a few months old; beyond this age the result of the fermentation is apparently only nitrous acid, and this nitrous acid does not further change into nitric, even in several years, unless a certain visible change occurs in the solution to be presently mentioned. When a solution which has undergone this nitrous fermentation is used as seed, it again produces a purely nitrous fermentation, the nitrous acid being constant as before. The nitrous ferment just described is without effect on nitrite of potassium.

The results just mentioned are perfectly in accordance with the facts recently published by Pasteur, who finds that by allowing the cultivation of an organism (as that producing chicken cholera) to become old, an organism is obtained of diminished energy, and which when cultivated continues to produce organisms of the same diminished energy.

If solutions which have nitrified are kept for a considerable time, a white organism not unfrequently appears in spots on the surface of the liquid, and under favourable conditions spreads over the whole surface. Viewed by lens, it appears as a mass of interlaced fibres. This organism has been examined microscopically by Dr. M. Masters, F.R.S., and more fully by Prof. E. Ray Lankester F.R.S.; both pronounced it to be a bacterium. Wherever this surface organism appears, any nitrites that may be present are speedily converted into nitrates; a solution of nitrite of potassium is also speedily converted into nitrate. The experiments as yet made with this organism leave it doubtful whether it has any power of oxidising ammonia. This part of the subject requires, however, further investigation. There can be little doubt that this surface organism is a stage in the development of the nitrifying ferment.

The nitrifying ferment appears capable of existing in two, or perhaps three, conditions, producing definite chemical effects.

1. The nitric ferment of soil, which converts both ammonium salts and nitrites into nitrates.
2. The altered ferment, which converts ammonium salts into nitrites, but fails to change nitrites into nitrates.
3. The surface organism, which changes nitrites into nitrates.

* Read before the British Association, York Meeting, Section B.

ON THE CHROME IRON ORE OF JAPAN.*

By Professor EDWARD DIVERS, M.D.

The serpentine rocks of Japan, like those found elsewhere, contain small quantities of chrome iron oxide; but a few years ago masses of this mineral were sent from Oîta Prefecture (Bungo) to the Tôkiyô Industrial Exhibition, and its nature then recognised. It has lately been analysed in the laboratory of the Imperial College of Engineering, Tôkiyô, by my former pupil, Mr. T. Haga, now one of the Instructors in Chemistry in the College.

It is massive, has a specific gravity 4·50, and a hardness 5·5, and is of a grey-black colour without any shade of brown except where weathered. Its fracture is partly slaty, partly crystalline, showing numerous large faces inclined at all angles. Its lustre is resinous to submetallic, so that in appearance it is much like coal. Its powder is brown. Besides brown and green coatings on the faces of natural fractures in the mass, there are many small deposits of a greyish pink, but nearly white, soft, and unctuous mineral. The behaviour of this chrome iron oxide to heat, presents nothing needing to be recorded, beyond that it slowly *gains* in weight. It contains only traces of magnetic matter.

Reduced to very fine powder and heated for three hours with hydrochloric acid, 2·53 to 2·87 per cent dissolve, which, together with some of the silica in the ore, make perhaps 4 per cent decomposed. The soluble part has been separately analysed. An analysis of the soft white matter has also been made, but the portion of this which could be got was very small, and largely mixed with the chrome iron oxide. The following are the results of analyses:—

1. *The Whole Ore, Air-dried.*

	I.	II.	Mean.
Chromic oxide	59·39	59·20	59·30
Ferrous oxide	28·32	28·22	28·27
Chrome iron oxide ..	87·30		
Magnetite	0·29		
Magnesia	9·17	(9·10 to 9·24)	
Silica	1·58		
Alumina	0·80	(0·82 to 0·78)	
	99·14		

This leaves 0·88 for water (undetermined because of the difficulty arising from the already-noted absorption o

* Read before the British Association, York Meeting, Section B.

oxygen), additional oxygen if present, and other substances which may have escaped detection.

2. *The Part Decomposed by Hydrochloric Acid.*

	I.	II.	Mean.
Chromic oxide.. ..	0·32	0·38	0·35
Iron oxide (if ferric)..	0·53	0·55	0·54
Magnesia	1·17	1·44	1·30
Alumina	0·51	0·50	0·51
Silica (assumed as)			1·30

Part at least of the iron dissolved in the ferrous state. The residual ore still yielded traces of soluble matter to fresh acid.

3. *The Pinkish White Mineral.*

After allowing for 36·5 per cent of admixed chrome iron oxide.

Silica	32·6
Magnesia	28·7
Alumina with a little ferric oxide ..	27·4
Water (loss on ignition)	11·3
	100·0

This analysis was made by Mr. Kawakita, another of the Instructors, in the unavoidable absence of Mr. Haga.

The tabular statement of the composition of the ore shows that it is in almost exact agreement with that of pure ferrous chromite, as regards the ratio of iron oxide to chromium oxide. No such pure ore has hitherto been recorded as occurring, I believe, unless possibly in the papers of Christomanos, which I have only seen in abstracts. The insolubility of the iron in acids and its non-magnetic character prove that it is really combined as chromite. There remains the magnesia to account for. This cannot be in the free state, for not only is the occurrence of free magnesia in nature unknown and improbable, but in this mineral the magnesia, like the iron oxide, is for the most part insoluble in acid. From the abstracts (*Journ. Chem. Soc.*, 32) of his papers, I learn that Christomanos in one paper asserts that pure chromite is always $FeCr_2O_4$, and all other constituents of the ore, part of the matrix, and in another paper admits the existence of compounds of ferrous oxide with chromic oxide in three proportions other than that of the ordinary spinel type. I see nothing for the case of the Oïta ore, but to accept the view that the magnesia is a chemical part of it, the proportion of which, after deducting soluble magnesia, is almost exactly that required by the formula,—

$$MgO,2FeO,2Cr_2O_3,$$

corresponding to the $3FeO,2Cr_2O_3$ of Christomanos.

Almost Insoluble—

	Calculated for $MgO,4FeO,2Cr_2O_3$.	Found.
Chromic oxide	59·30	59·30
Ferrous oxide	28·00	27·90
Magnesia	7·78	7·93
	95·08	95·13

Soluble, and Silica—

[Above magnes. ferr. chromite (about)	0·57]
Hydrous magnes. alum. silicate.. ..	3·62
Magnetite	0·29
	99·04

The visible presence of the white mineral, and the magnetic character of a very minute part of the powdered mineral serve to confirm the propriety of the above arrangement.

The estimation of chromium and iron was made by the usual volumetric methods. To bring the ore into a soluble condition, Dittmar's method was employed, this method being very satisfactory, and, in Mr. Haga's hands, much easier than described in *Dingl.*

Fused borax 2 parts and dry potassium sodium carbonate 3 parts were fused together in a platinum crucible till effervescence ceased, and the whole cooled. About 1 part of very finely-powdered ore was then placed on the top, and the crucible covered and slowly heated to fusion. When the powder had become moistened with the melted flux, the lid was removed and the crucible kept at a red-heat by a Bunsen flame. The liquid mass was occasionally stirred with a small platinum spatula. When particles of ore were no longer visible in the mass adhering to the spatula, the heat was maintained for only a few minutes longer, and the crucible then quickly cooled to favour the detachment of the mass. One hour was sufficient for 1 grm. of ore, and half an hour for half a grm. In this time, indeed, all the chromium may not have become chromate, but it would be all soluble in acid. Should the time have been too short, particles of ore will be visible in the bottom of the fused mass after removal from the crucible, and the mass must then be replaced and again heated. Unless the time of heating has been prolonged, it is safer to dissolve all up in sulphuric acid, oxidise any unoxidised chromium salt with a few drops of permanganate solution, and remove excess of permanganate by sodium carbonate and alcohol. A temperaturature for fusion so high that the crucible becomes attacked by the fluxes is quite unnecessary.

ON THE SODIUM ALUM OF JAPAN.*

By Professor EDWARD DIVERS, M.D.

The mineral sodium alum, since called Mendozite, was described by Thomson in 1828, as occurring in S. America (St. Juan, near Mendoza). Its occurrence has not been noticed elsewhere.

Rammelsberg (*Mineral. Chemie*) gives a series of percentages as obtained by Thomson, and refers them to an alum with 20 molecules of water. Dana ("System of Mineralogy") gives a different series as obtained by Thomson, and refers them to an alum with 22 molecules of water.

My late assistant, Mr. J. Mori, once a pupil of the Royal College of Chemistry, South Kensington, analysed the specimen I have now to describe, and obtained the following results:—

	Found.	Calculated for $Al_2O_3,Na_2O,4SO_3,24H_2O$
Alumina	11·27	11·23
Soda	7·26	6·76
Sulphuric oxide ..	34·73	34·90
Water..	46·74 (by diff.)	47·11
	100·00	100·00

The soda is too high, otherwise the results are most satisfactory, but error in excess here is probable from imperfect ignition to expel ammonium sulphate. Thomson found 7·96 soda, whereas for 22 aq. alum only 7·1 are required. Potash is absent and only traces of iron, calcium, and insoluble matter are present.

Sodium alum, therefore, occurs in nature of the normal type with 24 molecules of water.

It occurs as an efflorescence on decomposing sodium felsite (albite), with pyrites scattered through it. It is found in the province of Idzumo in the prefecture of Shimané, Japan, not far from the coast. Like that examined by Thomson it is not produced by a *solfatara*, though Shimané, like many parts of Japan, includes such. The alum is said to be obtainable in considerable quantity, but as a second parcel forwarded to me was damaged in transit by the leakage of bottles of natural alum water, I have only been able to examine very small specimens as yet.

* Read before the British Association, York Meeting, Section B.

It occurs in two forms, one massive, finely fibrous, greyish white, translucent, and also in friable opaque tears, slightly coloured by iron hydrate or oxide.

TABLE FOR THE CORRECTION OF SACCHARIMETRIC TESTS BY INVERSION.

By P. CASAMAJOR.

In a paper "On the influence of Variations of Temperature on the Deviation of Polarised Light by Solutions of Inverted Sugar," published in 1879,* I endeavoured to show the principles on which is founded the method, so important in sugar analysis, of correcting the direct test of the optical saccharometer, by taking into account the test after inversion. In this communication I will assume that the reader is familiar with the subject, and I propose to enter only very briefly into it.

Clerget, to whom this method of correction is due, published a table in the *Annales de Chemie et de Physique* (vol. xxvi., 3rd series, p. 175), by means of which the desired rectification may be obtained without the need of any calculation, beyond taking the algebraical difference of the indications of the saccharometer before and after inversion. There is also a table by Dr. Tuchshmid which is essentially the same as Clerget's. Although these tables are published in several works on sugar, many persons who need to use them find great difficulty in obtaining them. There is the resource of copying them by hand, but they are so extensive that this would involve an amount of labour which few persons like to undertake.

The following table will be found useful by persons who have not those spoken of. It is very short, and it would be little trouble to copy it. It requires but one operation more than Clerget's table, which is to multiply the algebraical difference of the two readings by a certain factor, corresponding to the temperature of the inverted sugar solution at the time of observation.

To understand how the numbers of this table were obtained, we must bear in mind that the deviation, caused by inverted sugar, varies with the temperature. For a solution of pure sugar, giving 100 to the right, the indication, after inversion, is 44 to the left or -44, if the observation is made at 0° C. For every Centigrade degree above 0, the deviation becomes half a division less of the negative scale. If we call the temperature t, the law of deviations after inversion is given by—

$$-\left(44-\frac{t}{2}\right).$$

For a temperature of 10° C. the deviation is 139; for 20° C. the deviation is 134, &c.

If D is the indication of the saccharometer before inversion, and D′ the indication after inversion, D+D′ will be the algebraical difference, and for a solution of pure sugar with D = 100,—

$$D+D'=144-\frac{t}{2}.$$

If the direct test is not 100, and if we call the correct test Δ, we will have—

$$\frac{\Delta}{D+D'}=\frac{100}{144-\frac{t}{2}}$$

whence—

$$\Delta=D+D'\times\frac{100}{144-\frac{t}{2}}$$

If for every degree Centigrade, we calculate this quantity,—

$$\frac{100}{144-\frac{t}{2}}$$

we may form a table by writing it down opposite to every degree of temperature. We will then have, in a second column, the factors by which to multiply the difference of the indications before and after inversion, so as to obtain correct results. This table is given below.

Table of Factors corresponding to $\frac{100}{144-\frac{t}{2}}$

Degrees C.	Factor.	Degrees C.	Factor.
10°	0·719	26	0·763
11	0·722	27	0·766
12	0·724	28	0·768
13	0·727	29	0·771
14	0·730	30	0·774
15	0·732	31	0·777
16	0·735	32	0·780
17	0·738	33	0·784
18	0·740	34	0·787
19	0·743	35	0·790
20	0·746	36	0·793
21	0·749	37	0·796
22	0·752	38	0·800
23	0·754	39	0·803
24	0·757	40	0·806
25	0·760		

Numerical Example.—If the direct reading of the saccharometer is 90, and, after inversion, -27, the temperature being 25° C., then D+D′ = 117. Referring to the table we find, opposite to 25° C. the factor 0·760. This number, multiplied by 117, gives 88·9, which is the correct result.

UPON THE ACTION OF OXYGEN, OZONE, AND NASCENT OXYGEN UPON BENZENE.*

By ALBERT R. LEEDS.

I.—Oxygen.

The first set of experiments was instituted to determine whether oxygen alone, in sun-light or diffused light, or oxygen together with platinum black, in sun-light or diffused light, would oxidise benzene after long-continued exposure. In every case a negative result was obtained, except in that of oxygen and platinum black brought into contact with benzene and a little water in a litre flask, and exposed to the direct sun-light. In the course of a few hours the liquid became slightly yellow, and at the end of eight days was dark yellow and intensely acid. A large amount of oxalic acid had been formed, but no acetic acid and no phenol.

II.—Ozone.

The earliest experiments upon the action of ozone upon benzene were made two years ago with the object of further studying the remarkable products obtained by Houzeau and Renard in the course of their investigation upon this subject † Along with small amounts of formic and acetic acids, they obtained a gelatinous body which, when dried *in vacuo*, formed a white amorphous solid, and which they called ozobenzene. It was permanent only at low temperatures, and on gentle warming exploded with tremendous violence. Fearing the possible formation of this dangerous substance, the first experiment was made upon 1 grm. of benzene, but the amount operated

* See CHEMICAL NEWS, vol. xxxix., pp. 212 and 234; also *Journal of the American Chemical Society*, vol. i., p. 26; *The Sugar Cane*, vol. xi., p. 296; *Moniteur Scientifique*, Juin, 1879, p. 647; *Zeitschrif des Vereins*, July, 1879, p. 683.

* From the *Journal of the American Chemical Society*, vol. iii.

† *Comptes Rendus*, 76, 572.

upon was gradually increased, until in the eighth and final trial, it amounted to 35 grms. In some experiments the benzene was cooled by a freezing mixture; in other trials it was ozonised at common temperatures; and in the last the temperature was kept at 50°. The benzene was exposed to the oxygen, strongly ozonised by the silent discharge, and containing about 70 m.grms. of ozone in the litre, either in shallow dishes placed under a receiver through which the perfectly dry ozonised gas was kept flowing, or in Geissler bulbs connected with other bulbs to arrest the volatile products of ozonation. But in every case the results were the same. Large volumes of carbonic acid were given off, and the benzene, as it diminished in volume, became converted into a dark yellow, oily mass, containing crystals of oxalic acid. In other cases, when the ozonation was performed in bulbs, an amorphous blackish mass separated out on the sides of the vessels. From these residues no crystalline bodies could be obtained either by the use of solvents or by sublimation. No indications whatsoever were noted of the white explosive body spoken of by Houzeau and Renard.

Besides carbonic and oxalic, formic and acetic acids were obtained, the latter in considerable quantity. Especial care was paid to the detection of phenol, but, as far as our tests were concerned, no evidence of the presence even of a trace of this body was obtained. Hydrogen peroxide was likewise absent.

III.—Nascent Oxygen.

The fact that triatomic oxygen (O_3, ozone or active oxygen) is not capable of oxidising water to the form of peroxide of hydrogen, while monatomic oxygen (O, or nascent oxygen) is, rendered it probable that a similar difference would be observed in the effects of ozone and of nascent oxygen upon benzene. This supposition has been confirmed by experiment. The nascent oxygen was obtained by the action of phosphorus, partially submerged beneath the surface of water, upon air at common temperatures. When no benzene is present, the nascent oxygen oxidises the oxygen molecule to the form of ozone, the water molecule to hydrogen peroxide, and the nitrogen molecule in the presence of water to ammonium nitrate. But on the addition of benzene the ozone reaction disappears. The resulting products differ, according as the reaction takes place in sun-light or in diffused light. In the former case, after prolonged exposure, large amounts both of phenol and oxalic acid are formed, the phosphorus is converted into yellowish red amorphous phosphorus, and the liquid remains colourless. In the latter case, the flask being kept in a warm place, the liquid becomes of a dark brown colour, and abundance of oxalic acid, but no phenol, is formed. At common temperatures the phosphorus goes into solution in the benzene, and is gradually converted into a mass of white dodecahedral crystals, the liquid remaining colourless. It is only when the temperature is above the melting-point of the phosphorus (in these trials 50° to 70°) that the dark brown liquid is produced. Curiously enough, though the flask becomes filled with dense white fumes, no inflammation took place at these elevated temperatures, the benzene vapour apparently protecting the phosphorus from ignition. Excess of calcium chloride was added to the syrupy liquid, the dense precipitate of calcium phosphate and oxalate (somewhat dark from a portion of the organic matter carried down at the same time) filtered off, and the filtrate evaporated to dryness. The soluble portions were then dissolved out with the least possible amount of water, the excess of calcium precipitated out by potassium sulphate, the whole evaporated to dryness, and treated with absolute alcohol. As a small portion of the potassium chloride was taken up by the alcohol, this extract was again evaporated to dryness, and the operation repeated three times, when only the organic matter remained in solution. It was of a yellow colour and pasty consistence, but as it could not be made to crystallise, and furthermore was in small amount, its further investigation was abandoned.

After my own research was in progress I found that Prof. F. Hoppe-Seyler,* starting out from similar views as to the effects resulting from the action of nascent hydrogen upon oxygen, had performed a series of interesting experiments with hydrogenised palladium foil. A piece of such foil shaken up along with benzene, water, and air, in a flask, and allowed to stand for a time, yielded an amount of phenol sufficient, after its conversion by the addition of bromine water into tribromphenol, for analysis. Besides the phenol, Hoppe-Seyler obtained a body which turned brown on the addition of potash.

On repeating the experiment I obtained a very abundant reaction for phenol. On addition of lime-water, the colouring-matter which had been formed at the same time was thrown down as a yellowish brown precipitate. Not a trace of oxalic acid was present.

To my own mind no satisfactory explanation could be given of the formation of phenol under these circumstances, except upon the supposition of the production of peroxide of hydrogen as an intermediate step. In the case of phosphorus oxidising in moist air, the contemporaneous formation of both ozone and peroxide of hydrogen, by the action of the nascent oxygen upon the oxygen and water, is a demonstrated fact.

Three suppositions therefore were admissible:—Either the phenol was formed by the direct action of the nascent oxygen; or 2nd, by the action of the ozone; or 3rd, by the action of peroxide of hydrogen. The first supposition requires that the oxygen should produce by direct synthesis a molecule of phenol, which is in the highest degree improbable. The second supposition is inadmissible, since the non-formation of the phenol by treatment with ozone had been abundantly proven. The third supposition admitted of the rational explanation expressed by the formula, $C_6H_6+HO-OH=C_6H_5OH+H_2O$.

Two modes of testing the validity of the third hypothesis presented themselves. The first was that of bringing the hydrogenised palladium foil into contact with water and air in a flask, and ascertaining if the oxygen rendered nascent by oxidation of the hydrogen would oxidise the water to the form of hydrogen peroxide. In case an affirmative result was obtained in this experiment, it would be important to try the second test of treating benzene directly with a peroxide of hydrogen solution.

A strip of palladium, after remaining for several hours as the negative pole of a battery of six Bunsen elements, in water acidulated with sulphuric acid, was placed, along with 10 c.c. of ammonia-free water, in a half-litre flask filled with air. At the end of three days the water was tested with guaiacum and solution of diastase. It developed a deep blue colour. On addition of cadmium-iodide-starch solution, iodide of starch was formed, and on titration with sodium hyposulphite it was found that the total quantity of hydrogen peroxide present in the 10 c.c. of water amounted to 0·67 m.grm.

It is not improbable that both ozone and ammonium nitrate are likewise formed in the course of this reaction, but of the former no satisfactory indication was obtained, and the latter was not looked for, inasmuch as it would have required the repetition of the experiment on a much larger scale and with many additional precautions.

The successful issue of this experiment encouraged us to try what otherwise would not have been attempted—the treatment of the benzene with H_2O_2. Twenty c.c. of benzene were allowed to stand at common temperatures for two days in contact with 300 c.c. of a slightly acidulated 1·2 per cent solution of hydrogen peroxide. The liquids remaining colourless, the flask was attached to a reflux condenser and placed in a water-bath. After the water in the bath had been kept boiling for several days, it was saturated with chloride of calcium, and the digestion continued at this temperature for two days longer. At the end of this time the liquid had become yellow, and was found to contain, beside the colouring-matter, oxalic

* *Ber. der Deutsch. Chem. Gesell.*, 12, 1551.

acid and phenol. A very abundant precipitate was thrown down from the aqueous solution on addition of bromine water, and this precipitate of tribromphenol, after recrystallisation from alcohol, was found to weigh 0·25 grm.

In conclusion, not only is the direct conversion of benzene into phenol by the action of hydrogen peroxide of much interest, phenol having hitherto been obtained only by some indirect process, but it supplies a satisfactory demonstration of the validity of the third hypothesis above stated.

NOTE ON THE PRECIPITATION AND PURIFICATION OF BARIUM SULPHATE.

By T. O'CONNOR SLOANE, A.M., Ph.D.

To obtain a precipitate of barium sulphate that will not run through the filter-paper, the following rules should be observed:—The solution should be barely acid. This end in best secured by the use of cochineal or some equivalent solution. By using the coloured matter in the fluid form, a solution can be neutralised in quarter of the time, and with far more exactness than when its reaction is tried with litmus paper. The precipitant is added when the solution is nearly boiling, and the liquid is kept at that temperature for some time. A heavy precipitate will be formed with perfectly clear supernatant liquor. It is quite certain if any iron be present that some will be carried down, and the ignited barium sulphate will not be white. Many ways of treating the precipitate after ignition have been recommended. I will refer to only two in the hurried way. The first is, to boil it with dilute hydrochloric acid; the second, to boil it with concentrated sulphuric acid, then dilute and filter. If the first course be pursued, any barium sulphide present will be dissolved, thus causing a loss. This is quite a common case, as the filter-paper reduces the sulphate in the ignition. If treatment with concentrated sulphuric acid be adopted, any other salts of barium present will be rendered insoluble, and excess of weight be caused. In the dry way, fusion with sodium carbonate and a little sodium nitrate, and subsequent determination of the sulphuric acid, may be recommended as very efficacious, but it is troublesome.

Some time ago I had occasion to make a great many sulphur determinations in coal. I was much annoyed by the precipitation of iron with the barium sulphate. I adopted the following simple method of purification, and it always secured a perfectly white precipitate:—

The sulphuric acid was precipitated with great care, as already described, so as to obtain a clear supernatant fluid. The solution was decanted to the last drop through a filter-paper. To the precipitate left in the beaker were added 5 or 10 c.c. of concentrated hydrochloric acid. The beaker was then carefully held over and just touching a hot plate until the acid was in full ebullition. By holding the beaker in an inclined position there will be no danger of spirting. The boiling was kept up for about a minute. After cooling it was diluted, cochineal solution added, over-neutralised with ammonia, slightly acidified, and filtered. This always gave perfectly white precipitates.—*Journal of the American Chemical Society.*

QUALITATIVE TEST FOR CARBON DISULPHIDE AND CARBON DIOXIDE IN COAL-GAS.

By T. O'CONNOR SLOANE, A.M., Ph.D.

A PIECE of caustic potash a few m.m. long is dissolved in 10 to 20 c.c. of alcohol. If, after standing protected from the air, a homogeneous and clear solution remains, it is ready for use. Otherwise, after settling, the clear fluid may be decanted. It is placed in a suitable absorption tube, and a cubic foot or more of gas passed through it. It is then poured into a test-tube. If the gas contained carbonic acid, an oily-looking colourless solution of potassic carbonate in water will underlie the alcohol. This last will be coloured more or less.

The alcoholic solution, if any carbon disulphide was in the gas, will contain a so-called xanthate of potash, and may be boiled and tested for sulphuretted hydrogen.

A more demonstrative method is to add excess of copper salt, filter out the precipitated cupric compounds, and pour ammonia through the filter-paper, when a highly characteristic precipitate of cupric xanthate will remain on the filter-paper.—*Journal of the American Chemical Society.*

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.*

By JOSIAH PARSONS COOKE, Director.

IN a paper presented to the Academy, and published in its *Proceedings*, vol. xiii., page 1, we gave the results of our investigation of the haloid compounds of antimony up to that time, including a revision of the atomic weight of this element. We did not directly answer the criticism which this paper called forth, except so far as to present to the Academy, March 10, 1880, and to publish in these *Proceedings*, vol. xv., page 251, a preliminary notice of experiments then in progress which furnished the best possible answer to the unfounded assumptions of the critic. We also gave brief notices of our work from time to time in the *American Journal of Science*. But now that the work is ended for the present (or at least must be suspended for a considerable period), we propose to bring the results together in the present paper.

1. THE OXIDATION OF HYDROCHLORIC ACID SOLUTIONS OF ANTIMONY IN THE ATMOSPHERE.

In our first paper (*loc. cit.* page 21) we made the following incidental observation in explanation of certain precautions which we found to be necessary in order to secure the precipitation of pure antimonious sulphide:—

"The precautions here described may seem unnecessary to those who are not familiar with the fact that a solution of antimony in hydrochloric acid oxidises with very great rapidity in the air,—fully as rapidly as the solution of a ferrous salt. A solution reduced as we have described, which has at first no action on the iodised starch paste, will strike the blue colour after it has been exposed to the air for only a few minutes. This property of an acid solution of antimonious chloride is mentioned by Dexter, in the paper already referred to, but we were wholly surprised by the energy of the action. By means of it, antimony can be dissolved in hydrochloric acid without the aid of nitric acid, or of any other oxidising agent save the air, if only a certain amount of antimonious chloride has once been formed. When, after exposure to the air, the solution is boiled over pulverised antimony, the solution is reduced, and a further portion of the metal enters into solution. After a second exposure, the same process can be repeated, and so on indefinitely. The process is very slow and tedious, but, in one experiment, we succeeded in bringing into solution in this way several grammes of antimony."

On the sole basis of this language we have been represented as asserting that such antimony solutions oxidise in the air as rapidly as a solution of *ferrous chloride*, and experiments on comparatively dilute solutions of antimonious oxide in hydrochloric acid have been adduced as proofs that our observation was incorrect.

As is evident from the context, the statement just quoted, although the result of a very extended experience, was not based on quantitative measurements. What we noticed

* Presented to the American Academy of Arts and Sciences, May 11, 1881.

was that the solutions *were very quickly acted on* by the oxygen of the atmosphere, and we freely admit that the expression here italicised is a more accurate description of our observation than the words originally used as quoted above. But our meaning was not left in doubt, for we expressly say, immediately after, that the process is very slow and tedious. In regard to the phenomenon in question, the effects are so obvious, when once attention is called to them, that it is entirely unnecessary to confirm our previous observations except so far as to add the following quantitative determinations, which will serve to give an accurate idea of the extent of the action under the only conditions we have investigated, or in regard to which we have written.

In order to determine the amount of oxidation caused by the action of the atmosphere on a solution of antimony in hydrochloric acid, we reduce the oxidised solution by boiling the liquid over antimony bullets, and determined the loss in their weight. This method is fully described in our original paper, and is based not only on the reducing of the metal, but also on the fact repeatedly observed, that, after the reduction was complete, the smallest excess of the finely pulverised metal would not dissolve, even after prolonged boiling, and in the presence of a large excess of acid, if only the solution was protected from oxidation.

We began our experiments by dissolving 1·0036 grms. of pure antimony (a portion of the same used in our experiments on the synthesis of antimonious sulphide) in about 30 cubic centimetres of pure hydrochloric acid (sp. gr.= (1·175), adding 3 cubic centimetres of very dilute nitric acid containing only about 5·4 per cent of HNO_3). After the solution was completed we added bullets made of pure antimony (the same that had been used in our previous experiments), and boiled the solution in an atmosphere of carbonic dioxide, using the same apparatus which we described in our previous paper (*loc. cit.*). After the reduction was ended, the solution was transferred to a flat-bottomed flask through a platinum tunnel, on which the bullets were retained; and, after washing into the flask the last traces of the solution, with as small an amount of hydrochloric acid as possible, the tunnel was removed, the bullets washed with water, and again weighed as at first on the platinum tunnel. In reducing the original solution, 0·4100 of a gramme of antimony were dissolved from the bullets. The solution now containing 1·4136 grms. of antimony was next exposed to the air for different successive periods of time in a room having a varying temperature of from 15° to 30°, sometimes in the shade, and at other times on a window seat, where the sun's direct rays fell on the flask during several hours of each clear day.

We give in the following table the weight of antimony dissolved from the bullets after each sucessive exposure to the air, the amounts in each case being determined with all the precautions described above, and still more at length in our former paper:—

Weight of Sb originally dissolved		1·4136
1. Dissolved from balls after 3 days' exposure,		0·0150
2. „ after 5 days		0·0295
3. „ „ 10 „	May 17 to May 27	0·0600
4. „ „ 23 „	May 27 to June 19	0·1340
5. „ „ 37 „	June 19 to July 26	0·2960
6. „ „ 120 „	July 26 to Dec. 24	0·4481
		0·9826

During these experiments the volume of the solution was gradually increased by the hydrochloric acid used in washing as above described, so that at least the volume amounted to 100 cubic centimetres.

It will be noticed that the amount of oxidation increased with the time of exposure, and that, so long as the amount was small, it was as nearly proportional to the time as could be expected under the varying conditions. The increased activity shown by determination No. 5 appeared to be due to the intensely warm weather and bright sunshine during the period, and the last determination would seem to indicate that, after the oxidation reached a certain limit, the process went on more slowly, as we should naturally expect; but, with the greatly varying conditions during this long period, no certain conclusion can be drawn in regard to the effect of any single cause.

The action we are discussing is entirely in harmony with the chemical relations of antimony. The most striking characteristic of this elementary substance is its tendency to form compounds of the radical antimonyl, SbO. The oxychlorides, the oxybromides, and the oxyiodides, whose relations we have discussed so fully in our previous papers, are examples in point, and we have been continually surprised by the appearance of such compounds in reactions in the most unexpected ways. In this respect antimony closely resembles vanadium, and with this element antimony is more closely allied than with its familiar associate, arsenic. What the precise reaction is in the present case we are not prepared to state. That it is not the simple conversion of a terchloride into a pentachloride we are convinced; but, in order to elucidate the subject, further investigations are necessary.

In this connection we may appropriately add that while the above determinations were in progress we repeated the experiment described on page 19 of our previous paper (*loc. cit.*). We treated in an open flask 5 grms. of finely powdered pure metallic antimony with 50 cubic centimetres of strong and pure hydrochloric acid, to which we added only 1 cubic centimetre of the very dilute nitric acid (5·4 per cent) described above. The flask was placed in a warm, protected place (30° C.), and shaken from time to time. Soon the acid became coloured reddish-yellow, and the chemical action began. When it had apparently ceased, the contents of the flask were shaken together, and the solution became at once as colourless as water; but, on standing in the air, the colour rapidly returned, spreading from the surface of the liquid downward. These phenomena were repeated again and again during four or five months, untill the whole of the metal dissolved. According to the reaction usually assumed to take place under these circumstances, 5 grms. of metal would have required 50 cubic centimetres of acid, so that the effect was obtained with only one-fiftieth of the amount required by this theory.*

(To be continued.)

NOTICES OF BOOKS.

The Structure of the Cotton Fibre in its Relation to Technical Applications. By F. H. BOWMAN, D.Sc., F.L.S., F.C.S., F.G.S., &c. Manchester: Palmer and Howe. London: Simpkin and Marshall.

WE have here a very interesting and elaborate monograph based upon microscopical and chemical investigation, and valuable both from a scientific and an industrial point of view. The contents of the work were first laid before the public in a course of three lectures delivered before the students of the Bradford Technical School, during the spring of 1880. Their publication was requested at that time, but Dr. Bowman wished to complete and to publish at the same time a series of investigations on the structure of wool. As, however, other engagements have prevented,

* Although in our synthesis of antimonious sulphide it was our constant study from the first to prevent the oxidation of the product and although we most carefully guarded every phase of the process yet the theory was advanced that the apparent weight of the product was *increased* by a partial oxidation of the antimonious sulphide at the temperature at which the red was converted to the grey modification. In answer to this wholly gratuitous assumption, it is only necessary to say; 1. That the oxidation of the dried precipitate at this stage of the process is a well-marked phenomenon, with every phase of which we are acquainted. 2. That the oxidation is always attended with a *loss* of weight. 3. That the products of our determinations were always examined, and have been in two cases preserved, and that these do not show the least signs of oxidation.

for the time being at least, the execution of this design, the author has been induced to issue the present volume as it stands.

Dr. Bowman begins with some very appropriate remarks on the importance of technical knowledge, upon which, speaking not merely as a man of science, but as a practical manufacturer, he feels that the future of this country must greatly turn. He complains that, as a nation, "we have been unquestioningly following the rules of thumb which practical experience has shown will lead to certain desired results, without inquiring or considering whether these might not be better obtained in some other way." He adds:—"We often go astray in assuming that a process is far more simple than it really is, and in so doing we often overlook something which would, if observed, lead us to alter our method of procedure entirely," —a very judicious hint. Here, as in several passages of the book, the author insists on the value of the microscope to the manufacturer and the dyer. By its use the causes of unexpected and puzzling imperfections in the goods may often be detected, and a way struck out to avoid them in future. Before discussing the typical structure of the cotton fibre, he briefly notices the species of the cotton-plant, concerning the number of which botanists are by no means agreed. He gives tables of the length, diameter, and variation in the fibres from different sources. Next follows an account of the changes which the fibre undergoes whilst ripening. In early stages of their formation the growing cells are filled with juices of an astringent character, whilst in the ripe fibre the cell walls consist of almost pure cellulose. Hence it may be readily foreseen that the action of mordants, colours, &c., will be modified according as the fibre is mature or not, or as its development has been modified by unfavourable season. As regards the microscopical character of the fibre Dr. Bowman substantially confirms the results obtained by Mr. Walter Crum, F.R.S., in 1863. He describes its general appearance as that of "an irregular, flattened, and somewhat twisted tube, the tubular form in some cases being entirely lost, and the appearance resembling that of a wrinkled, twisted, irregular ribbon." By these characters it is easily distinguished from the fibres of wool and silk. As regards the internal structure of the fibre when seen by transmitted light, the author divides cotton fibres into three classes: Those where no internal structure is apparent, as occurs most frequently in immature and in over-ripe cotton; those whose structure is simply tubular, and those where the interior of the cell is filled up with secondary deposits. Want of visible structure is sometimes owing to a part of the length of the fibre being filled up with a solid, transparent, but impermeable matter. Such fibres, which the author calls "kempy," and indeed all fibres not perfectly cellular, do not dye up a full shade, but receive merely a slight stain. Hence their occurrence in cotton goods is a great inconvenience to the dyer and printer, who are often perplexed to account for the uneven and meagre shades they obtain. Mr. Crum, as is well known, held that the dyeing of cotton was almost a purely mechanical operation, the outer sheath of cellulose acting as a dialyser. With this view the author does not entirely agree. He admits the osmotic action of the sheath of cellulose, and considers that this action should be carefully studied with a view to regulating it at pleasure. He admits, also, that cellulose is, chemically speaking, a body of a very inert or indifferent character. Still, he considers it not improbable that in some cases tinctorial matters may unite with cellulose, forming compounds sufficiently stable to resist the action of water. But whether these are true definite compounds, such as those of acid and base, he thinks unproven. The fixation of the colour may further depend, not upon the cellulose itself, but upon the juices of the plant not fully transformed into cellulose.

The following is an interesting example of the necessity of cleanliness in manufacturing operations, and of the very trifling causes, as they seem to the outsider, which interfere with the dyer's success:—A number of pieces were found covered with small white marks where the thread had refused the dye. These spots were visible in all shades, but more in slates and blues than in browns and blacks. Microscopic examination proved that the fault was not due to the presence of any foreign fibre, or of immature cotton. But these spots were always associated with a knot in the yarn, or a thicker place—"the result of a piecing up of a roving, either in the card-room or spinning room." The fingers of the work-people had come in contact with the threads at these points, and the perspiration and moisture of the skin had caused the parts to resist the dye! In proof of this theory, grey pieces out of the same lot were scoured before dyeing, and came up perfectly free from spots.

The following incident is also instructive:—One season, when very fine Egyptian yarns were being used, chiefly for delicate shades, the author was consulted in cases where individual fibres and masses of fibres had turned black or dark wherever salts of iron had been used in dyeing. This blackening arose from the presence of a tannin-like body present in the juices of the growing cotton-fibre, and which from the want of sun during the growing season had never changed into more neutral compounds. The next season, with the same class of goods and the same dyes, this defect hardly ever was met with.

Passing over much matter valuable to the spinner and weaver, but of no chemical interest, we find the author returning at length to the theory of dyeing. He considers that in wool and silk there is an affinity for colouring-matters, producing true chemical combination. He agrees in fine with the illustrious Chevreul that colours are fixed in the fibre by chemical affinity, by mechanical mixture, or by the joint action of both. Exceedingly valuable are the illustrations, showing cotton fibres in different states dyed with turmeric, indigo, aniline-blue, and alizarin, all magnified 450 diameters. On comparing them, we find that the unripe pellucid fibre, and still more the "kempy" fibre, have received the colour merely in spots or blotches, the rest of their tissue remaining perfectly white. In the fully-ripe fibre the colour is much more evenly distributed, and no white patches appear.

The author holds that we are still "far remote from the standard of perfect dyeing," and that we are much more advanced in the mechanical than the chemical treatment of the raw material. "One of the directions in which we are to look for increased perfection in our finished goods must be in the determination of the means which can be employed in the preliminary preparation of the fibre, so as to enable it better to perform its function as a dialyser, and thus absorb a larger amount of colouring-matter, and distribute it more evenly."

We must here conclude this slight sketch of Dr. Bowman's work by pronouncing it a most valuable contribution to tinctorial literature, and by expressing the hope that he may soon find opportunity to complete his investigations on the fibre of wool.

Technical Vocabulary, English-French, for Scientific, Technical, and Industrial Students. By Dr. F. J. Wershoven. London, Paris, and Boston: Librairie Hachette et Cie.

We have often remarked with dissatisfaction to what a degree scientific and industrial words and phrases are excluded from ordinary dictionaries and vocabularies. We find men who are, *e.g.*, very good French scholars, who can read a French novel or play as if to the manner born, and can converse with freedom and elegance. But of industrial and technical French they know no more than they do of Chinese. Certainly in an age like the present this is a state of things at once discreditable and inconvenient. For multitudes of people the only motive for studying the French language is the desire to have at

command its scientific and technical literature. Dr. Wershoven deserves the gratitude of all this numerous class for the work before us, which will prove a valuable companion for all who are studying the applied sciences. After a careful examination of this vocabulary we are happy to bear testimony to the accuracy with which French technical phraseology is rendered into idiomatic English. It must be remembered, however, that the book, the English and French indexes excluded, runs merely to 268 pages, which is but small scope for the technical language of the sciences and their connected arts. The biological sciences and their applications in medicine, in hygiene, and agriculture do not fall within the author's plan. The chemical manufactures, too, receive a less share of attention, comparatively speaking, than does pure chemistry, or than do the mechanical arts. Dyeing, tissue-printing, bleaching and colour making, the manufactures of soap, manures, &c., figure here but to a small extent. On the other hand, beer, sugar,—which can scarcely any longer rank as an English manufacture—and paper are dealt with at some length, as are also earthenware, glass, and metallurgy. One of the very few instances of an expression not perfectly idiomatic is on page 156. Speaking of the standard (French) for gold coin he writes—"The law allows a variation (an allowance of 3-1000)." The English term here is a "remedy." It would be very difficult to do more than Dr. Wershoven has effected within such narrow limits, and we venture to suggest to him the desirability of a companion volume, taking up the thread where it is here let fall.

Elements of Agricultural Chemistry and Geology. By the late Professor J. F. W. Johnston, F.R.S., and C. A. Cameron, M.D., &c. Twelfth Edition. W. Blackwood and Sons: Edinburgh and London.

The appearance of the twelfth edition of this standard work may serve as a reply to certain remarks in a work on the same subject which it was our duty not long ago to examine. In the volume before us English literature does possess a work on agricultural chemistry fully on a level with the present state of science.

The principal new features of this edition are a summary of the experimental results of Messrs. Lawes and Gilbert, and an account of the recent experiments on phosphatic manures made by the Agricultural Association of Aberdeenshire. The latter experiments seem to point to conclusions not quite in harmony with generally received theories. The Association felt warranted in declaring "that phosphates of lime decidedly increase the turnip crop; but that farmers need not trouble themselves to know whether the phosphates are of mineral or of animal origin." Hitherto mineral phosphates, undissolved, have commonly been valued at a decidedly lower rate than animal phosphates, and "bone manures" have fetched more money than ordinary superphosphate, though containing neither a large percentage of "soluble phosphate" nor of total phosphates.

The second conclusion, based on the results of forty experiments, is likewise novel—"That soluble phosphate is not superior to insoluble phosphate to the extent that is generally supposed."

As concerning nitrogenous manures, they infer from one hundred experiments that—"Nitrogenous manures have little effect on turnips used alone, but when used along with insoluble phosphates they increase the crop; that the addition of nitrates to soluble phosphates does not seem to increase the solids or dry matter in crop; that there is no material difference between the effects of equal quantities of nitrogen in nitrate of soda and in sulphate of ammonia; that fineness of division seems nearly as effective in assisting the braird and increasing the crop as the addition of nitrogenous manures. Hence the most economical phosphatic manure for turnips is probably insoluble phosphate of lime, from whatever source, ground down to an impalpable powder."

Another course of experiments consisted in applying different classes of phosphates, with or without nitrogen, to the land in one year, taking then three successive crops of turnips without further manuring, and noting which application was most productive for the three years' period. Highest stood: steamed bone-flour, dissolved phosphate with nitrogen, and roughly crushed bones. In a medium class came undissolved phosphate with nitrogen, and mineral phosphate, either dissolved or undissolved. Lowest came animal phosphate, dissolved or undissolved.

We certainly think that the different kinds of manure here mentioned are not specified with the needful clearness. We want to know the difference between the "undissolved animal phosphate" in the lowest class and the "steamed bone-flour" in the highest. But if the results obtained in these experiments are confirmed under other circumstances of soil and climate superphosphate must without doubt decline in public favour. If, as seen in the lowest class, dissolved and undissolved animal phosphates give substantially the same results, why need we go to the cost of making sulphuric acid and applying it to the bones?

In certain experiments performed by Dr. Cameron on mangels, finely-ground coprolite gave per equal weights of anhydrous phosphoric acid, a heavier crop than coarse bone-ash, which is a much more expensive article.

Certain experiments described by Dr. Voelcker are remarkable as pointing in the same direction. He applied finely-ground coprolites, Redonda phosphate, precipitated phosphate, and raw bone-meal in comparison with dissolved coprolites, using the same money's worth in each case. As compared with an unmanured plot ground coprolites gave an increase of 3¼ tons of swedes per acre, Redonda phosphate 5¼ tons, bone-meal only 1 ton 13 cwts., precipitated phosphate 5 tons 6 cwts., dissolved bones 5 tons 13 cwts., and dissolved coprolites 6 tons 13 cwts. These results present Redonda phosphate in a new light. As an aluminium and iron phosphate it has been neglected as incapable of supplying food to plants. But as in these experiments it surpasses bone-meal and precipitated phosphate, and falls but little short of dissolved phosphates, its value must be re-considered.

As regards the direct assimilation of atmospheric nitrogen by plants, the authors, in agreement with Boussingault and in opposition to Ville, decide in the negative. The statement that urea is assimilated by plants without decomposition is fully proved by Ville and Hampe.

The authors mention that on the Lodge Farm, Barking, there have been produced ten crops annually of Italian rye-grass of about 9 to 10 tons each. But how much of this is merely water!

The present edition of this work is admirably got up, and furnished with a double index—for the subject-matter and for the authors referred to.

CORRESPONDENCE.

BLOWPIPE CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Blowpipe Chemistry, or "Pyrology," is now pretty generally admitted to have been heretofore much neglected in England, France, and even Germany, except at Freiberg. It is the travelling mineralogist's chief assistant, and ought to be (next to a knowledge of palæontology) the geologist's. The modern discriminating chemist has almost come to delegate to it and to the spectroscope his entire qualitative work. The metallurgist now regrets that he has neglected to devote at least a chapter to its merits, whilst even the chemical agriculturist and the medical practitioner would find, by treating poisoned organisms and then healthy ones in boric acid, &c., separately before the blowpipe, such radical reactionary differences as would probably enable the results to afford to a

clever man, provided with a microscope, valuable clues of the causes of all disease. The farmer, or intending purchaser of lands, by treating weeds grown in soils or manure heaps in the same simple manner, would arrive at a fair qualitative knowledge of the chief mineral characteristics of the latter, without the expensive or nasty resort of a regular analysis.

The above are a few advantages which, I believe, would immediately follow a little more encouragement by some of our leading physicists and chemists of the study of pyrology by means of the simple mouth-blowpipe or hand-blower; but if the science were once fairly grasped and applied *on the large scale* by such men as those, it seems to me obvious that some remarkable and most important discoveries would soon be made by them. For instance, boric acid has been found, when treated before the blowpipe with various substances, to afford novel and interesting reactions and chemical compounds, unexpected even at Freiberg. What, then, would be the probable results and benefits to science should one of the distinguished men above alluded to, with the means placed at his disposal by a rich and appreciative government or people, treat its analogue silicic acid *as a reagent* similarly before the oxy-hydrogen blowpipe? It is evident that many minerals (silicates) could be *made* in this way, and important knowledge afforded to geologists and others of the actual working of Nature in the formation of some of her rocks. The only question would be as to the nature of a support for the assay which could withstand heat sufficient to fuse silica, and I would suggest the trial of a *thick* piece or block of aluminium for the purpose.—I am, &c.,

W. A. Ross.

Acton, W., October 26, 1881.

SOURCES OF POTASH.

To the Editor of the Chemical News.

Sir,—Owing to the restriction of the output of potash salts at the Stassfurth and other salt-mines in Germany, the relations between supply and demand for potash products is so strained that the price of muriate has risen to £8 7s. per ton f.o.b. Hamburgh for 80 per cent, and there does not seem to be any reason why further action of the German Government may not occasion a still greater advance in price. However pleasant this may be for producers of potash salts in this and other countries, consumers of the article in question who are compelled to pay the high price for muriate without being able to secure an advance in the returns for their finished article, naturally feel aggrieved at the position in which they are placed. As one of the grumblers may I ask, through the medium of your journal, if any attempts have been made to find sources of potash, similar to those in Germany, in the vicinity of our salt deposits. It is said that the potash salts now so extensively worked at Stassfurt and Leopoldshall received at first the name "abraumsalze," because common salt being the mineral sought for, they were looked upon as rubbish or waste (hence the word "abraum"). These now valuable salts occur in beds of great thickness over the rock-salt deposits. In opening out the new salt fields of Fleetwood and Middlesborough, I would like to call the attention of those concerned to the possible existence of similar potash deposits, knowing that the discovery and working of such would not only relieve us from a monopoly foreign to us in more senses of the word than one, but prove a source of profit to the owners.—I am, &c.,

Kalium.

Manchester, October 26, 1881.

Reaction for Gallic Acid.—Ammonium picrate produces in solutions of gallic acid a red colouration, which in a few seconds passes into a fine green. Pyrogallic acid and tannin give also a red, which remains unchanged.—*Polyt. Notizblatt.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 14, October 3, 1881.

Decision of the Congress of Electricians on the Unities of Electric Measures.—For these measures there are adopted the fundamental unities—centimetre, gramme, second, and this system is briefly designated by the letters C. G. S. The practical units, the *ohm* and the *volt*, will retain their present definitions; the ohm is a resistance equal to 10^9 absolute unities (C. G. S.), and the volt is an electromotive force equal to 10^8 absolute unities (C. G. S.). The practical unit of resistance (ohm) will be represented by a column of mercury of 1 square m.m. in section at the temperature of 0° C. An international commission will be charged with ascertaining for practice, by means of new experiments, the height of this column of mercury representing the ohm. The name *ampère* will be given to the current produced by the electromotor force of 1 volt in a circuit whose resistance is 1 ohm. *Coulomb* is the quantity of electricity defined by the condition that in the current of an ampère the section of the conductor is traversed by a coulomb per second. *Farad* is the capacity defined by the condition that a coulomb in a condenser, whose capacity is a farad, establishes a difference of potential of a volt between the armatures.

Application of Radiophony to Telegraphy. The Multiple-Inverse Electric Teleradiophone.—E. Mercadier.—This paper cannot be reproduced without the accompanying diagram.

A New Electro-Magnetic Pointer, destined for Experimental Researches.—G. Noel.—The author describes an instrument intended for physiological experiments.

Secondary Batteries.—J. Rousse.—In order to accumulate electricity for the production of light or motive power, the author has arranged secondary batteries, which differ from those of M. G. Planté. At the negative pole he uses a sheet of palladium, which, during the electrolysis, absorbs more than 900 times its volume of hydrogen. At the positive pole he uses a sheet of lead. The electrolysed liquid is sulphuric acid at 1-10th. This element is very powerful, even when of small dimensions. Another secondary element which has also given good results, is formed at the negative pole of a slender plate of sheet-iron. This plate absorbs more than 200 times its volume of hydrogen when electrolysed in a solution of ammonium sulphate. The positive pole is formed of a plate of lead, pure or covered with a stratum of litharge, or pure oxide, or all these substances mixed. These metallic plates are immersed in a solution containing 50 per cent of ammonium sulphate. Another arrangement is at the negative pole, sheet-iron; at the positive pole a cylinder of ferro-manganese. The electrolysed liquid contains 40 per cent ammonium sulphate.

A Manganese Battery, where the Salts are Utilised or Regenerated.—J. Rousse.—Instead of the zinc in a Bunsen element the author uses ferro-manganese. As the liquids, he uses sulphuric acid at 1-20th and concentrated nitric acid, or if a feeble current is required, instead of the latter, potassium permanganate. The salts produced are manganese sulphate and nitrate.

Levulose.—MM. Jungfleisch and Lefranc.—Not suitable for abstraction.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. June, 1881.

Position of the Copper Trade in the Year 1880.—The total consumption of copper in Germany for the year

1880 is given as 406,116 cwts., and the total production as 204,480 cwts.

Part 7, 1881.

Development of the Synthesis of Indigo.—Prof. Liebermann.—A discourse delivered at the meeting of the Society, July 4, 1881. The author summarises the researches of Prof. Baeyer, and admits that from this quarter there is no immediate danger to the production of natural indigo.

Die Chemische Industrie.
Vol. 4, No. 4.

Preparation of Potassium Sulphate from the Crude Potassium Salts of Stassfurt.—Dr. H. Gruneberg.—A summary of patents relating to the potash manufacture.

Separation of Alumina from Ferric Oxide.—H. Beckmann.—The author shows that the caustic alkalies used for this purpose are contaminated with silica, alumina, and organic matter which render the separation uncertain. He proposes the use of baryta water, which, contrary to the earlier statement of Vauquelin, dissolves alumina completely, and has the advantage of not acting upon silica.—*Verein. Naturw. Braunschweig*, 1880.

Vol. 4, No. 5.

Synthetic Production of Nitric Acid.—Atmospheric air streams through a series of closed vessels, and is exposed to the action of the electric spark, whereby hyponitric acid is formed, and is carried by the current of air into an absorption-column traversed by potash lye. The air and the liquid flow in opposite directions, so that a moderately concentrated solution of potassium nitrate flows off below.—*Moniteur Indust.*, vii., p. 526.

Determination of the Value of Lead Peroxide.—H. Fleck.—A weighed quantity is placed in a small flask fitted with a gas-delivery tube, and decomposed with dilute hydrochloric acid. The chlorine evolved is passed into a solution of potassium iodide. When the escape of gas has ceased the solution is titrated with sodium hyposulphite, and the percentage of lead peroxide is calculated from the quantity of iodine. In rich samples the moisture should be determined specially.—*Repertorium Anal. Chem.*

Vol. 4, No. 6.

General Congress of German Manure Manufacturers, Dresden, May 23.—The first question discussed was the influence of recent experiments on manuring with precipitated phosphate and "Kladno-phosphate" (a by-product from dephosphorising iron-ores by Jacobi's patent) upon the consumption of superphosphate. The general opinion was that precipitated phosphate could not become a dangerous competitor, whilst the production of the Kladno-phosphate was likely to diminish in consequence of the introduction of the Thomas and Gilchrist process. The next questions considered relate merely to import duties. As to the value of Seltsam's process for extracting from bones by means of benzol, the general opinion was that the additional quantity of fat obtained was not great, and that the quality was objected to by purchasers. The question whether organic nitrogen is equal in value to the nitrogen in ammonia and nitrates remained undecided, as the respective experimental results varied according to soils, methods of cultivation, &c. In a long discussion on the use of ammonium citrate, it appeared that iron phosphate is much more soluble in an ammoniacal than in a neutral citrate solution, whilst Koninck and Thiriart have shown that recently-precipitated alumina phosphate is very readily soluble in ammonia. The citrate process was pronounced to be the foundation of a correct method of determining the value of superphosphates.

Vol. 4, No. 7.

This number is taken up with abstracts of patent specifications and extracts from other journals.

Vol. 4, No. 8.

Analysis of Sulphuric Anhydride and Fuming Sulphuric Acid.—O. Clar and J. Gaier.—The difficulties to be encountered here depend on inaccuracy in weighing substances so highly hygroscopic, and on losses in consequence of the violent reaction on diluting with water prior to titration. The authors, after criticising known methods, give a process which cannot be intelligibly described without the accompanying illustration.

Journal de Pharmacie et de Chimie.
July, 1881.

Pharmacologic Study of Atropine.—J. Regnauld and F. Valmont.—The atropine of medicine is a mixture in variable proportions of two isomeric alkaloids, atropine (of Ladenburg) and atropidine (hyoscyamine of Ladenburg).

Researches on Formic Ethers.—MM. Berthelot and Ogier.—These ethers, like the oxalic and the acetic ethers, are formed with absorption of heat.

Artificial Production of Vivianite.—J. Girardin.—Already noticed.

Transformation of Morphine into Codeine and Homologous Bases.—E. Grimaux.—From the *Comptes Rendus.*

Complex Function and the Constitution of Morphine.—P. Chastaing.—Already noticed.

Assay of Commercial Methylic Alcohols Used in the Denaturation of Ethylic Alcohol.—C. Bardy.—The wood-spirit used in France for admixture with alcohol for industrial purposes is required to contain 40 per cent of pure methylic alcohol. As an easy method of ascertaining its quality, the author proposes to determine its chief residual ingredient, aceton. The method which he proposes depends on the transformation of aceton into iodoform in presence of soda-lye and a solution of iodine in potassium iodide. His process will be described in a future number.

A Compound of Iodoform and Strychnin.—M. Lextrait.—The compound in question is very unstable, being decomposed by light. It is also decomposed by a temperature of 90°, by boiling-water, by ether and chloroform, and in part by alcohol. The author assigns to it the formula—$(C_{42}H_{22},N_2O_4)_3C_2HI_3$.

Determination of Salicylic Acid in Beverages.—A. Rémont.—Beer and cider are previously freed from carbonic acid by heating to 58° or 60°. Wine is concentrated to one-third of its volume by heating to from 70° to 80°. The liquid when cold is treated three times with its volume of ether washed with water. The agitation should not be too violent, lest the ether forms an emulsion. Each treatment with ether is followed by a decantation. The collected ethereal solutions are freed from ether first by distillation and then by spontaneous evaporation. The residue is weighed, and treated by its volume of chloroform, washed in water, and applied in three portions. The chloroformic solution is allowed to evaporate, and the residue is treated repeatedly with water till all acidity is removed, and the solution is then made up to 100 c.c. This solution, submitted to a colorimetric test in comparison with a freshly-prepared solution of salicylic acid, contained 0·2 grm. per litre.

On Sewage.—H. Bouley.—This paper contains the strange assertion that the sewage of London is treated by the irrigation system.

Journal für Praktische Chemie.
No. 12, 1881.

On Two New Nitro-phenols.—F. Fittica.—The two compounds obtained and examined by the author are respectively the fourth and the fifth mono-nitro-phenol,—a result not in harmony with the "benzol hypothesis."

Putrefaction Compounds of the Brain.—Florian Stockly.—The principal compounds obtained were skatol and paracresol, fatty acids from the acetic to the capronic inclusive, hydrocinnamic acid in considerable quantities, small quantities of pepton, and traces of leucine. If the products of putrefaction are examined at an earlier stage succinic acid is obtained, which after forty-eight hours is no longer to be found.

Chemical Examination of the Ambrosius-Spring at Marienbad, in Bohemia.—Dr. W. F. Gintl.—A very elaborate investigation, which shows that the character of the water in question has changed considerably since it was analysed by Dr. Raysky, in 1860.

On Isomalic Acid.—M. Schmœger.—The author has obtained the zinc and silver salts of this acid in the form of crystals. He does not consider it identical with the methyl-tartronic acid of Bœttinger.

Notes, by E. Drechsel:—

1. A Crystalline Guanine.—The author finds that guanine, contrary to the assertion of the text-books, is soluble in ammonia, and can be obtained from the solution in crystals.

2. A Modification of Pettenkofer's Reaction for the Biliary Acids.—The author uses, instead of concentrated sulphuric acid, syrupy solution of phosphoric acid, which he mixes with a concentrated solution of the alkaline salts of the biliary acids, adds a little sugar, and heats the whole in a small test-tube plunged into a flask of boiling water.

3. On Calomel.—Calomel readily dissolves in a solution of mercuric nitrate at a gentle heat, with formation of mercuric chloride and mercurous nitrate. Mercuric chloride is precipitated, however, by mercurous nitrate, except an excess of mercuric nitrate is likewise present.

Anthology of Modern Chemical Utterances.—H. Kolbe.—A selection of passages the *curiosa infelicitas* of which would greatly escape in translation.

No. 13, 1881.

Attempt at a Determination of the Reactionary Value of the Components of the Alcohols and Acids.—M. Menschutkin.—A bulky memoir, not susceptible of useful abstraction.

Contributions to the Chemistry of the Chrome-Ammonium Compounds (III. Xanthochrome Compounds).—The xantho-salts can only be prepared through the intervention of the roseo-salts. The author describes the preparation, composition, and reactions of xanthochrome chloride, xanthochrome bromide, the corresponding iodide, nitrate, sulphate, dithionate, chromate, bichromate, platinum chloride, mercury chloride, carbonate, and hydrate.

Anthology of Modern Chemical Declarations.—H. Kolbe.—A collection of illogical, ungrammatical, &c., passages from the writings of Lossen, Merz, Weith, and Wislicenus.

Gazzetta Chimica Italiana.
Anno 10, Fasc. 5 and 6.

Observations and Researches on Blood-Stains.—D. Vitali.—Attention has been recently called to a reaction discovered by Schœnbein—the blue colouration produced by a mixture of oil of turpentine and alcoholic tincture of the resin of guiacum, on the addition of a little blood or a very dilute solution of hæmoglobin. It is said that this reaction is preferable to any other, not excepting that founded on the formation of crystals of hæmine and on spectroscopic observation, and that none of the substances capable of simulating blood-spots give the same opaque blue colour. The author, however, shows that all substances capable of acting as direct or indirect oxidising agents are capable of producing the same reaction.

On the Neutral Cerium Tungstate.—Prof. A. Cossa and Mario Zecchini.—The authors determine the atomic weight of cerium = 138.

On Certain Derivatives from Natural and Synthetic Thymol.—E. Paterno and F. Canzoneri.—The authors examine the action of nitric ether on the methylic ether of nitro-thymol, that of dilute nitric acid upon the methylic ether of nitro-campho-thymol, and the composition of dibromo-oxymethyl-toluic acid.

On Sacchulmic Acid.—Fausto Sestini.—The author ascribes to this acid the formula $C_{11}H_{10}O_4$.

Experiments on Cumo-phenols.—Dr. P. Spica.—An account of the action of mono-chloracetic acid upon para-cumo-phenol in an alkaline solution, and upon ortho-cumo-phenol in presence of soda.

Sulphacids of Cymene.—Prof. P. Spica.—The author, in contradiction to numerous chemical authorities, shows the existence of two cymenic sulph-acids.

On a New Phenol.—Dr. G. Mazzara.—The phenol in question is obtained by melting the potassium salt of para-ethyl-methyl-benzol-sulphuric acid with potassa. Its composition is $C_9H_{12}O$.

Researches on Blood-Stains.—Dr. Dioscoride Vitali.—The author gives further details on the application of Schœnbein's test for the detection of blood.

MISCELLANEOUS.

Cantor Lectures.—The following are the subjects of the courses of the Society of Arts Cantor Lectures for the Session just about to commence:—First course, on "Some of the Industrial Uses of the Calcium Compounds," by Thomas Bolas, F.C.S. Second course, on "Recent Advances in Photography," by Captain Abney, R.E., F.R.S. Third course, on "Hydraulic Machinery," by Prof. John Perry. Fourth course, on "Book Illustration, Old and New," by J. Comyns Carr. In connection with Capt. Abney's lectures it is intended to arrange for an exhibition of photographic apparatus, processes, &c. These Lectures originated in 1863, with a bequest to the Society of Arts by the late Dr. Cantor. Since that date three or more courses have been given every Session, each course dealing with some application of Science or Art to Industry or Manufactures.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sulphuric Test for Anthracen.—I have been trying to ascertain for some little time the *modus operandi* of a test called Meister's sulphuric test for anthracen, obtained in the distillation of coal-tar. None of my friends here appear acquainted with it. Could any of your correspondents kindly enlighten me?—S. Baker, Jun.

MEETINGS FOR THE WEEK.

Saturday, Nov. 12th.—Physical, 3. "On Spirals in Crystals," by Lewis Wright. "On Integrating and other Appliances for the Measurement of Electrical and Mechanical Forces," by C. V. Boys.

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ANALYSIS BY JOHN PATTINSON, ESQ.

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1146.

ON THE OCCURRENCE OF SELENIUM AND TELLURIUM IN JAPAN.*

By Professor EDWARD DIVERS, M.D.

At the Sulphuric Acid Works of the Imperial Japanese Mint, and at a private works, both in Osaka, the sulphur now employed comes from different parts of Japan, Kagoshima, Oïta, Hokkaido, &c. In some of the sulphuric acid made there I have found not inconsiderable quantities of selenium, and Mr. M. Shimosé, one of my pupils, has also found more than traces of tellurium. Arsenic is also present in quantity.

A former pupil of mine, Mr. Nakagawa, now a chemical engineer in the Imperial Mint, states that the flue deposits of the sulphur burners is rich in selenium.

I had hoped to have obtained by this time fuller particulars, but have been disappointed by not receiving in time supplies of acid and flue dust. I must therefore limit my communication to the announcement of the presence of these two elements in Japanese sulphuric acid, and of the probable occurrence of material quantities of selenium in Japan. A further communication will be published when particulars have been ascertained.

THE DIRECT PRODUCTION OF PHENOL FROM BENZENE.

By C. T. KINGZETT, F.I.C., F.C.S.

At a meeting of the New York Academy of Sciences on March 14th of this year, Dr. A. R. Leeds, of the Stevens Institute of Technology, made a communication† relating chiefly to peroxide of hydrogen, ozone, and benzene. Among other matters of interest therein referred to, he describes an experiment wherein 20 c.c. of benzene had been digested with 300 c.c. of a slightly acidulated 1·2 per cent solution of hydrogen peroxide during some days and under certain conditions as to temperature, &c. :—"At the end of this time the liquid had become yellow, and was found to contain, beside the colouring matter, oxalic acid and phenol." Benzene does not absorb oxygen when exposed to the air in sunlight or otherwise, and therefore it is unlike the terpenes and certain other classes of hydrocarbons in this respect. This observation was recorded by the writer some years ago,‡ and Dr. Leeds confirms it in his paper.

After reading Dr. Leeds's communication it occurred to me that it would be interesting to ascertain if phenol is produced by placing benzene in prolonged contact with air, water, and a hydrocarbon known to give rise to the formation of peroxide of hydrogen by aërial oxidation in the presence of water. Accordingly, I have conducted some few experiments to determine this question, and although the obtained results are chiefly negative in character, the matter is of sufficient interest to justify a brief description.

Experiment A.—100 c.c. benzene were mixed with 100 c.c. of Russian turpentine; 100 c.c. of water were added, and the mixture was maintained at 60° C. during some six or seven days, and exposed meanwhile to a current of air. Attached to the vessel containing this mixture was a wash-bottle charged with cold water, in order to condense, so far as practicable, such substances as might be volatilised in the oxidiser and carried over in the air-current. From time to time further quantities of benzene and turpentine were placed in the oxidiser. As the oxygen was absorbed the oil-mixture became dark yellow in colour and increased in density: the aqueous solution also became coloured. It was proved by actual determinations, which were made from day to day, that the presence of the benzene did not interfere with the production of the peroxide of hydrogen.* Thus, on the seventh day, 5 c.c. of the aqueous solution contained H_2O_2 equal to 12 c.c. N/10 $Na_2S_2O_3$ solution, and the oxidised oil-mixture was proved to contain a large amount of that organic peroxide which by contact with water gives rise to the peroxide of hydrogen.

On the third and seventh days the aqueous solutions contained in (both) the oxidiser and the wash-bottle were examined for phenol, which substance was not found present. An addition of excess of bromine water caused the liberation of oxygen gas, but yielded no precipitate of tribromo-phenol, nor did the solution give any of the other reactions characteristic of phenol.

On the seventh day the oil-mixture itself was tested for phenol, by agitating a part of it with caustic soda, separation of the alkaline extract, neutralisation of this with dilute sulphuric acid, and examination of the solution thus obtained. Phenol was not found present. After the seventh day, more benzene and turpentine were added to the oxidised oil-mixture, and the temperature raised to 100° C., a reflux condenser being attached to the oxidiser. The air-current was then kept up for several days, after which, however, the aqueous solution still contained some peroxide of hydrogen (100 c.c. = 10 c.c. N/10 thio-sulphate), but apparently no phenol. The oxidised oil was now of a very dark yellow colour and quite thick. The bulk of the aqueous solution was rendered strongly alkaline by dissolving caustic potash therein, and this solution was then well agitated with the oil-mixture. This treatment caused the whole mass to become almost black by the direct absorption of oxygen from the air, strongly reminding the observer of the behaviour of pyrogallic acid. After a shor time the alkaline lye was separated from the oil, and neutralised with dilute hydrochloric acid, filtered from a little tarry matter, and the resulting solution carefully examined for phenol and pyrogallic acid.

1. Treated with a great excess of bromine water it became milky, and in course of time deposited a slight amount of yellowish substance. This deposit presented characters distinct from those of tribromo-phenol, but almost identical with those of the similar or identical substance which is precipitated from an aqueous solution of thymol on addition of bromine water. It was readily soluble in absolute alcohol and in ether, and was reprecipitated from the alcoholic solution on the addition of *much* water.

2. With ammonia and calcic hypochlorite the produced reaction was not that of phenol, but resembled that given by a dilute solution of pyrogallic acid examined concurrently.

3. With ferrous sulphate it developed a greenish blue colour, like that which can be obtained by adding dilute acid to the pyrogallic blue obtained side by side.

4. With ferric chloride the solution was coloured reddish brown.

5. On addition of excess of caustic soda it darkened very much, and oxygen was absorbed from the air.

6. It reduced potassic permanganate just as acid pyrogallic solutions do.

Experiment B was practically a repetition of the first experiment, and identical results were obtained.

On this occasion it was observed that the substance which gives the slight precipitate with bromine water is lost—presumably by volatilisation—if the faintly alkaline

* Read before the British Association, York Meeting, Section B.

† See Chemical News, vol. xliv., p. 219.

‡ *Journ. Chem. Soc.*, 1874, p. 513.

* *Journ. Chem. Soc.*, vol. xiii., p. 210, and Chemical News, vol. xxxii., p. 138.

solution be heated on the water-bath with the view of concentration.

On testing dilute solutions of thymol, pyrogallic acid, and phenol side by side with the product of the experiment, the results clearly confirmed the impressions made by the earlier observations. The behaviour with bromine water was exactly that of a dilute thymol solution, and the precipitate has precisely the same properties. The general behaviour towards reagents closely copied that of pyrogallic acid, but in no case was any reaction obtained clearly suggestive of phenol. It is quite true that neutral salts like chloride and sulphate of sodium do materially interfere with many of the reactions for phenol; but as regards the most important test—with bromine water—that is not the case, and except in the most attenuated solutions this reaction produces a bulky flocculent precipitate, quite distinct from the partly adhesive and finely-divided nature of the deposit which is obtained from thymol and the product of the experiment described above.

In Dr. Leeds's experiments a higher temperature was observed during the latter part of the time, since he saturated his water-bath with calcic chloride, but long before that period was reached his 1·2 per cent solution of hydric peroxide must have been largely decomposed, and as it would then probably not exceed in strength that of the peroxide of hydrogen present throughout my experiments, any phenol which was formed was produced in all probability in the earlier stages of his experiment. His tribromo-phenol weighed 0·25 grm., but no analysis of the product is given in the paper from which I have gathered this fact. The total weight of bromine water precipitate obtained in my observations was, I believe, considerably greater, but yet not sufficient to enable me to conduct any analyses.

I hope Dr. Leeds will be enabled to continue the study and afford some analytical information in support of the direct formation of phenol. I am rather of the opinion that in my experiments the benzene suffered no change, and it is certainly remarkable that benzene admits of oxidation by a 1·2 per cent solution of hydric peroxide.

It is not my intention to continue the investigation of the subject of the experiments herein described.

BREWING IN JAPAN.

By R. W. ATKINSON B.Sc. (Lond.).

The origin of the method of brewing used in Japan cannot be certainly known, but it is generally believed that it was brought over from Korea by some emigrants from that country. However that may be there is little doubt that it was employed in China at a period long anterior to that at which it became known in Japan, and as far as can be learnt, the process of manufacture was the same.

As in our brewing process the manufacture of Japanese *saké* is divided into two parts, the first of which in its aim corresponds with malting, the second with mashing and fermentation, but beyond this general resemblance the two industries have little in common. I will, therefore, divide this description into two parts, the first treating of the material which is used in place of malt, and for which I am compelled to employ the Japanese word "*koji*," the second describing the subsequent conversion of the rice-starch, first into sugar, and subsequently into alcohol, the product being called in Japanese *saké*.

I. Kōji Making.

This material, *koji*, is usually preserved in masses upon shallow wooden trays, and when examined will be seen to consist of grains of rice deprived of the embryo, and bound together by the interlacing threads of the mycelium of an air-fungus. A section taken through a single grain shows that the outer layers are loose and penetrated by the mycelial fibres, whilst in the centre the outlines of the cells can be faintly seen with very few grains of starch, which, indeed, have been gelatinised by a steaming process preparatory to the growth of the fungus. A comparison of the chemical composition of the koji with that of the rice from which it was produced, shows that the most important change is the conversion of the insoluble albumenoids of the rice into a soluble form, which is accompanied by the solution of much of the starch in the form of dextrose and dextrin, when the koji is treated with water.

	A. Whitened Rice (Dried at 100° C.).		B. Koji (Dried at 100° C
Insoluble in water—			
Starch	82·27	per cent	56·00
Cellulose	4·79	,,	4·20
Fat	0·49	,,	0·43
Ash..	0·46	,,	0·09
Albumenoids.. ..	7·50	,,	1·50
Soluble in water—			
Albumenoids.. ..	1·95	,,	8·34
Dextrose	1·91	,,	25·02
Dextrin			3·88
Ash..	0·63	,,	0·52
	100·00	,,	99·98
Water	12·70	,,	25·82

The percentage of starch calculated from the amounts of starch, dextrose, and dextrin present in the koji amounts to 82·4, a number nearly agreeing with that present in the original rice. Other analyses confirm these results, the proportions of starch, dextrose, and dextrin alone varying in the koji.

When the koji is treated with cold water, digested for some time, and filtered, a yellow solution is obtained which possesses the property of rendering thick starch-paste liquid within a very short time, five or seven minutes at 15° C., and half-a-minute to two minutes at a temperature of 45° C. This solution of koji contains dextrose and dextrin together with albumenoids derived from the rice, in quantities which vary according to the proportion of water used for solution, and according to the duration of the digestion. When the koji remains in contact with the water for a short time only, the specific rotatory power of the liquid is much higher than when the digestion is longer continued, and this is due to the circumstance that the albumenoid matters require a perceptible time before being degraded by the action of the water, so that the liquids resulting from short digestion contain a smaller proportion of nitrogenous matter, and hence the dextrose and dextrin exert a more energetic effect upon polarised light.

The effect of a higher temperature is to increase the amount of matter dissolved in a given time, and if the digestion be conducted at a temperature of 50° to 55° C. for three or four hours almost the whole of the starch may be brought into solution in the form of dextrose. The most favourable temperature appears to be 55° C.; above 60° C. solution is much less rapid, and is accompanied by a precipitation of a part of the albumenoid matter.

It is to the presence of this albumenoid matter that solution of koji owes the active properties for which it is prepared and used, and I have compared its action upon various carbohydrates with that of malt extract with this result, that whilst the latter effects the hydration of cane-sugar, dextrin, and starch, the former hydrates maltose in addition to the others, which malt-extract does not do. In this respect, therefore, the diastase of koji shows a marked difference from that of malt, and this property necessarily renders the nature of the products of its action upon starch-paste different, malt-extract producing as final products maltose and dextrin, whilst koji forms dextrose and dextrin, or if the action be long continued dextrose alone. The first product of the action upon starch-paste is, however, maltose, and it is only by the further action

of the solution that this undergoes hydration, but as the diastase of koji is very powerful the maltose may not be found unless care is taken to avoid using an excess of the active agent. The conversion of starch into dextrose and dextrin goes on even at 0° C., the rapidity of solution increasing until it attains a maximum at 55° C., above which it diminishes, and at some point near 70° C. becomes entirely inactive.

The points in which the extract of koji differs from that of malt are these:—1st in causing the hydration of maltose, and, 2nd, in the lower temperature at which its activity is destroyed, but a further difference lies in the essentially distinct mode of production of which I may now give a short sketch.

The grains of rice are in the first place deprived of the husk before being sent into the market by the farmer, and the koji maker further removes the testa from the grain by beating in a wooden mortar by which not only is the thin outer coating of the endosperm removed, but many of the grains are broken, and from all the embryo is detached. The broken grains, the testa, and the embryo are separated and used for various purposes, whilst the cleaned entire (except for the absence of embryo) grains alone are converted into koji. They are next steeped in water and washed thoroughly to remove the dust adhering to them, after which they are steamed till the starch is gelatinised, and the grains have become flexible and horny looking. This takes from half-an-hour to one hour, after which the steamed rice is thrown on to straw mats and cooled, the workmen turning it over all the time to keep the grains separate. When sufficiently cold (about 26° C.) the foreman mixes a small quantity of the spores of a mould with a little of the rice, and then scatters the mixture over the remainder, the men working the whole up thoroughly with the hands. In this state it is allowed to remain in the cool part of an underground chamber for about twenty-four hours, where it preserves nearly the same temperature as at mixing. In most cases, but not always, water is sprinkled over the heaps, which are then spread out on shallow wooden trays, and transferred to the innermost of the underground chambers, where the temperature is kept pretty constantly about 80° F., at least whilst work is actively going on. In these chambers the mixture of rice and spores remains for about thirty-six hours, during which time the spores throw out filaments of mycelium, and the temperature of the mixture on the trays gradually rises until it attains a maximum of about 106° F., some 20° to 25° F. above the temperature of the enclosure, carbonic acid at the same time being abundantly formed and oxygen absorbed. A slow circulation of air provides for the supply of oxygen and the removal of carbonic acid, the ventilation being effected merely by the warmer air rising up a square shaft at the end of the chamber to the air above. The chambers are in reality merely long low passages cut out in the clay about 15 or 20 feet below the level of the ground, and are about 50 feet long, 5 feet broad, and 4 to 5 feet high. As soon as the masses on the trays have become matted together by the threads of mycelium, and the temperature has risen to about 106° F., the workman spreads the material out in shallow layers to lower the temperature, that there may be no danger of it becoming spoilt, but after having cooled down several degrees he once more collects the mixture into heaps and permits the temperature to rise a second time to nearly the same point as at first. When the temperature has risen sufficiently a second time the rice, or koji, as it has now become, is again spread out, and left for the remainder of the time, during which it gradually cools down till it has the same temperature as the chamber.

The trays are removed and preserved in cool dry places until they are required for use. During this process the rice loses about 11 per cent of its weight calculated on the dry rice used, and it is by this species of combustion that the temperature of the chambers is kept up (for no external heat is applied), the carbonic acid and water liberated, and the oxygen used up. During the winter, when the production of koji is carried on most actively, the difference between the temperature of the chamber and that of the external air may be as much as 50° or 60° F., there being no greater variation in the chamber temperature than 4° or 5° F., whilst the temperature of the koji at times rises 25° F. above the temperature of the chamber. During the summer the amount of work diminishes, and there is then very little difference, sometimes none at all, between the outer and the inner temperatures, as a result of which the ventilation is much impaired and the growth of the fungus becomes weakened for want of the necessary oxygen. On this account the chambers are rarely used during the summer.

II. Mashing and Fermentation.

The koji thus prepared is used by the brewer for the purpose of bringing the starch of the rice into solution, and probably also because there are adherent to the grains of koji germs of the ferment, which subsequently convert the dextrose formed into alcohol and carbonic acid. The brewing operations are essentially two in number, the first being in order to obtain a quantity of vigorous ferment, and the second to allow the yeast prepared in the first process to effect the conversion into alcohol of the sugar already formed and that afterwards produced. The materials employed consist only of steamed rice, koji, and water, and although in different works the proportions vary slightly, those used at the works in Tokio may be given, as all the subsequent analyses refer to this mixture. In the first stage the proportions are the following, the quantities of steamed rice and koji referring to those bodies taken in the ordinary marketable condition of rice:—

Steamed rice	1·985 bushels
Koji	0·794 ,,
Water	15·880 gallons

This mixture is divided into several shallow vessels and thoroughly agitated: at first it forms a thick mass, but gradually, under the influence of the solution of koji, becomes thin and sweet-tasted. These operations are always carried out in the winter, and the mash at this period rarely has a temperature above 5° C., and generally rises very little above 0° C. After remaining in these shallow tubs for some time (several days) the mash is next collected in a single larger vessel, in which its temperature is raised by the introduction of closed wooden barrels filled with hot water. Almost immediately after heating fermentation sets in, and continues for several days, during which time the temperature rises to about 23° C. After being heated for a time, which varies in different breweries, the mash is returned to the shallow tubs and allowed to cool down. It then contains about 10 per cent of alcohol, but the object of this fermentation is not so much to produce alcohol as to obtain a ferment which in the second stage will cause the rapid conversion of dextrose into alcohol. The two following analyses show the composition of the mixture on the third and fifth days respectively before the heating had commenced.

	3rd day. Per cent.	5th day. Per cent.
Dextrose	7·35	12·25
Dextrin	5·12	5·69
Glycerin, ash, and albumenoids	trace	0·48
Fixed acid	0·017	0·019
Volatile acid	—	0·008
Water (by difference)	87·513	81·553
	100·000	100·000
Starch undissolved	20·43	15·46

The composition on the following days, after heating on the fifth day, is as follows.

	7th day. Per cent.	10th day. Per cent.	12th day. Per cent.	14th day. Per cent.
Alcohol	5·2	8·61	9·41	9·20
Dextrose	5·4	0·99	0·49	0·50
Dextrin	7·0	2·81	2·72	2·57
Glycerin, &c. ..	1·14	2·82	2·35	1·93
Fixed acid.. ..	0·31	0·24	0·31	0·30
Volatile acid ..	0·15	0·11	0·05	0·03
Water (by diff.)..	80·80	84·42	84·67	85·47
	100·00	100·00	100·00	100·00
Starch undissolved	10·68	12·46	11·55	12·05

The percentage of starch undissolved refers to the original weight of the materials used, the percentage in the original mixture before any change took place being 32·17, and is calculated by deducting from 32·17 the amount of starch equivalent to the alcohol, dextrose, and dextrin found in the liquid.

When the first stage is finished the mash is used like yeast, and mixed with fresh quantities of steamed rice, koji, and water in three portions, so that, including all additions, made the composition of the mash (supposing no change to have taken place) should be as follows:—

	Per cent.		lbs.
Dry rice.. ..	1450	=	34·7 (containing 29·15 starch)
Water	2724·7	=	65·3
	4174·7		100·0

The fresh quantities of koji are used for the purpose of effecting the solution of the additional quantities of starch, as the koji added during the first stage becomes quite exhausted. The addition of fresh food in the form of sugar causes the growth of the yeast present to take place vigorously, and the temperature of the mixture thus rises considerably, carbonic acid is given off explosively, and a fragrant odour spreads everywhere.

At the same time that the yeast is using up the sugar already formed, new quantities are being brought into solution by the action of the koji, and thus the two processes go on concurrently, the fermentation never being arrested by the presence of a large amount of sugar at any one time, and only stopping when the food is exhausted, or when the percentage of alcohol becomes so great that it kills the yeast. In this respect the Japanese brewing process differs from our beer-making; in the latter the activity of the diastase is destroyed before fermentation begins, so that, except by the direct addition of sugar, no increase in the amount of the latter can take place after the mashing is finished, and the total amount of alcohol formed cannot exceed that equivalent to the weight of sugar and dextrin in solution at the beginning of the fermentation.

The following are the analyses of the Japanese mash during the second stage:—

	17th day. Per cent.	19th day. Per cent.	21st day. Per cent.	24th day. Per cent.	28th day. Per cent.
Alcohol ..	5·80	9·44	11·83	12·41	13·23
Dextrose ..	2·06	1·16	0·27	0·27	—
Dextrin ..	3 89	2·74	1·42	0·47	0·41
Glycerin, &c.	0·043	1·09	1·98	1·68	1·99
Fixed acid..	0·015	0·03	0·058	0·086	0·107
Volatile acid	—	—	0·029	0·086	0·061
Water ..	88·192	85·54	84·413	84·998	84·202
	100·000	100·00	100·000	100·000	100·000
Starch undissolved—	12·814	7·85	5·534	5·4	4·18
Temperature..	19° C.	25°	26°	20°	12°

The alcohol steadily increases, whilst at no time is any considerable amount of sugar present; it is no doubt formed from the starch, but is as quickly used up by the ferment.

After this point is reached the mash is filtered, and the tuns rinsed out with water, which is added to the rest of the brew, a circumstance which explains the diminished percentage of alcohol in the filtered liquid, the composition of which was as follows:—

Composition of the Filtered Saké.

Alcohol	11·14 per cent
Dextrose	— ,,
Dextrin .. .. / Glycerin, &c...	1·992 ,,
Fixed acid	0·130 ,,
Volatile acid	0·020 ,,
Water	86·718 ,,
	100·000
Specific gravity	0·990

The insoluble residue retained 6 per cent of its weight of alcohol, which is recovered afterwards by distillation.

The analyses given below of various specimens of saké, produced in different breweries, show that there is no great variation in the composition of this liquid, and also that it differs markedly from beer in the very minute proportions of dextrose and dextrin which it contains.

The yield is not very good: in the process which I had the opportunity of thoroughly examining the quantity of alcohol obtained amounted only to 50 per cent of that theoretically obtainable from the starch, and the numbers given to me at Itami and Nishinomiya indicate a yield of 56·8 and 55·5 per cent respectively.

The fermentation appears to be spontaneous, and probably resembles the wine fermentation in the fact that the germs introduced are adherent to the materials employed.

Composition of Various Specimens of Saké From Itami and Nishinomiya.

	Itami.				Nishinomiya.				
Name of Saké	"Gaika."	"Hatsu-hikage."	"Shira-yuki."		"Iro zakari."	"Tai-riyo."	"Saki-gake."	"Kome-ichi."	"Zui-ichi."
Name of Brewer	Konishi Shin-yemon.	Konishi Shin-yemon.	Konishi Mote.		Idzumi Man-suke.	Tatsu Gonuske.	Tatsu yasu.	Tatsuma Kijiro.	
Alcohol	12·30	12·15	12·15	13·10	13·73	11·20	12·83	11·00	13·50
Dextrose	0·62	0·312	0·44	0·56	0·404	—	0·82	0·20	1·41
Dextrin	0·255	0·256	0·30	0·05	0·18	0·16	0·22	0·14	0·39
Glycerin, ash, and albumenoids..	1·530	2·15	1·857	1·46	1·833	1·81	1·22	1·58	2·02
Fixed acid	0·145	0·13	0·123	0·32	0·143	0·12	0·32	0·13	0·24
Volatile acid	0·015	0·01	0·032	0·03	0·026	—	0·014	0·014	0·013
Water (by difference)	85·135	84·992	85·098	84·48	83·684	86·71	84·576	86·936	82·427
	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000
Specific gravity	0·991	0·992	0·992	0·993	0·989	0·990	0·990	0·991	0·994
Specific rotatory power.. ..	36°	25·6°	33°	19·7°	24°	16·4°	37°	20·6°	41·6°

The average size of the full-grown ferment is 0·0082 m.m. in diameter, and the different specimens do not vary very much from that average. Whether it is a variety of a known species, or whether it differs from those already known, I am not able to say, but it certainly differs from *Saccharomyces ellipsoidens* in its uniformly larger size, and from most of the other wine ferments in the regularity of its form, whilst it differs from the beer ferment both in its smaller size and in its capability of living in presence of 12 to 15 per cent of alcohol.

The fermented liquid after filtration is clarified by being allowed to stand in large wooden tuns for about fifteen days, after which the clear liquid is decanted and preserved in store vats. During the hot months of summer the germs of various forms of disease develop in the saké, and to destroy them the brewer has for 300 years been accustomed in the spring to heat his wine to 120° to 130° F. This at first sight looks like a "Pasteurising" process, but the essential feature of that process is omitted, for after heating the saké is poured back into the same vats, and no precautions are taken to destroy the ferments left in the store vats. Hence the necessity is felt of keeping a constant watch over the saké, and on an average it requires to be heated about once a month during the five hot months of the year. After being kept the liquid contains a smaller amount of alcohol, the dextrose has disappeared, and the amounts of fixed acid (lactic) and of butyric acid have increased, but there is in addition ammonia formed from the albumenoid matter, and also a volatile oil, the nature of which has not yet been ascertained, but which, even more than the butyric acid, contributes to produce the disgusting odour which such "turned" saké possesses.

Two kinds of ferment cells are present in great numbers in the diseased saké, one of which resembles the ferment of "turned" beer figured in Pasteur's "Etudes sur la Bière," plate I., fig. 1, and the other almost identical with the ferment found in putrid beer figured in the same plate.

By modifying the heating process used in such a way as to keep the liquid out of contact with air, and to preserve it in clean barrels completely full, there can be no doubt but that the brewing industry in Japan might become more extensively developed, and furnish a larger proportion to the Revenue than it does at present, without making the consumption of alcohol remarkable; and such a source of revenue is much needed to relieve the farming classes from much of the pressure to which at present they are subject, the farmers contributing rather more than two-thirds of the entire revenue.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.*

By JOSIAH PARSONS COOKE, Director.

(Continued from p. 222.)

II. Argento-antimonious Tartrate (Silver Emetic).

On one occasion when analysing antimonious chloride we noticed the formation of "silver emetic," and the observation led us to fear that this compound might be occluded by the argentic chloride or bromide, precipitated from a solution containing tartaric acid and antimony. This suspicion, thus excited, led us to make an investigation of the substance in question, with the following results:—

As stated in our former paper, this compound was originally obtained by Wallquist by precipitating nitrate of silver with tartar-emetic, and was analysed both by him and by Dumas and Piria. These chemists obtained respectively 27·31 and 28·05 per cent of oxide of silver. They appear, however, to have prepared the substance only in an amorphous form. As stated in the paper just cited, we first noticed the formation of crystals of the compound in a concentrated solution of antimonious chloride and tartaric acid, to which had been added an excess of argentic nitrate, and from the circumstances of their formation we were led to form a somewhat erroneous inference in regard to their relation to water. We find that the substance is far more soluble in this solvent than at first appeared. We have found from further investigation that one part of silver emetic dissolves completely in one hundred parts of boiling, and in somewhat less than five hundred parts of water at 15° C. In one determination made by evaporating a saturated solution, which had stood a long time at a temperature of 15°, we found that one thousand parts of water had dissolved 2·76 parts and in another 2·68 parts of the salt. There is obviously therefore no danger of the formation of this product in the precipitation of chlorine, bromine, or iodine from solutions of the antimony compounds of these elements in tartaric acid, unless the excess of silver nitrate is very large and the solutions very concentrated; and although we have most carefully looked for it in the precipitate we have never discovered it, except under the peculiar conditions described in our former paper, and our fear that it might be occluded by these precipitates was wholly unfounded.

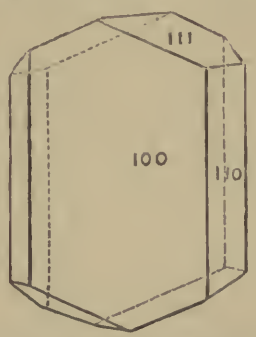
It is evident from the above experiments that the solubility of silver emetic in water, like that of cream of tartar and other salts of tartaric acid, is very greatly increased by heat, and we were easily able to obtain good crystals of the compound in large quantities by dissolving the precipitate, obtained as Wallquist describes, in boiling water, and allowing the solution to cool. The crystals are colourless and have a very brilliant, almost an adamantine, lustre.

From the reaction by which silver emetic is formed we should infer that the composition of the salt would be expressed by the symbol

$$Ag,SbO,H_2''''O_4''''(C_4H_2O_2).H_2O.$$

This compound would theoretically contain 26·34 per cent of silver and, as a mean of three analyses, we obtained for the amount of silver in the crystals 26·30 per cent, as previously stated.

The crystals of silver emetic rapidly blacken in the light, and are very easily decomposed by heat. This decomposition takes place at about 200° C. with a slight explosion. A very fine carbon dust is blown out of the crucible, and a residue is left behind, which under the microscope is seen to consist of spangles of metallic silver mixed with an amorphous powder. Almost the whole of



the powder dissolved easily in a solution of tartaric acid, and it evidently consisted of Sb_2O_3. In one experiment we weighed the silver emetic and the product, and found that 0·8460 grm. of the salt left 0·5304 grm. of residue. If the residue consisted solely of silver and Sb_2O_3, theory would require 0·5200 grm., and it can be seen from this how perfect the decomposition was. It is obvious, therefore, that were this compound occluded as we at first

* Presented to the American Academy of Arts and Sciences, May 11, 1881.

feared, it would have made itself evident on drying the precipitates.

Mr. W. H. Melville, assistant in this laboratory, has made the following crystallographic measurements of the crystals whose formation and reactions we have described.

Angles between Normals.

(111) ∧ (100) 70° 19½'
(111) ∧ (1̄11) 70° 17'
$a : b : c = 1 : 1{\cdot}386 : 0{\cdot}571.$

	I.	Measured.
100 ∧ 110	54° 12'	54° 19'
111 ∧ 110	54° 51'	54° 54'

The pinacoid planes were irregular, and the angles can only be regarded as approximate.

System Trimetric with Hemihedral Habit.

Observed planes + κ {111} {100} {110} {011} ?

In the following table the crystallographic ratios are compared with those of the acid tartrates of rubidium, cæsium, and potassium, formerly measured by us, and which have the same general form and hemihedral habit.

	Vertical.	Macro.	Brachy.
Acid tartrate of cæsium ..	0·661	1	0·694
" " rubidium ..	0·695	1	0·726
" " potassium .	0·737	1	0·711
Silver emetic	0·412	1	0·721

III. On the Solubility of Argentic Chloride in Water.

In our analyses of antimonious chloride we constantly noticed, while washing the precipitated chloride of silver with warm water, that although the water first decanted from the precipitate was perfectly clear, it became turbid when mixed with the successive washings; and on investigating the cause of this unexpected result, we found that it was due to the chloride of silver dissolved by the pure wash water, and re-precipitated by the excess of nitrate of silver in the filtrate. As the solvent action of the water used for washing the precipitate evidently produced a marked effect on our chlorine determination, we determined at once to investigate the extent of the influence.

This subject has already been studied by Stas, whose observations are summed up by Dr. John Percy,* in his recent volume on the Metallurgy of Silver, in the following words:—

"The solubility of the chloride is greatest when in the flaky state, as precipitated in the cold from a sufficiently dilute solution of silver; the solubility diminishes as the flakes shrink when left to themselves, or as they are rendered pulverulent by long agitation with water. Flaky or pulverulent chloride of silver, dissolved in water, pure or acidified by nitric acid, is precipitated by the addition of a salt of silver, or of hydrochloric acid, or of an alkaline chloride. . . . . The solution of the chloride is wholly effected by pure or acidified water, as the case may be, and is not caused by the soluble salt formed simultaneously with the chloride of silver. The presence of nitric acid in the water does not affect the solubility of flaky chloride of silver; but it increases the solubility of the pulverulent chloride in proportion to the quantity of acid present. The precipitation of the dissolved chloride is the exclusive result of its insolubility in the solution formed by adding an excess either of the silver salt or of the alkaline chloride."

So also in Liebig and Kopp (*Jahresbericht*, 1871, 339): —"According to Stas, the granular scaly and crystalline chloride is wholly insoluble in cold water: in boiling water the solubility is comparatively great, but decreases rapidly with the temperature."

In our own investigation of this subject we have at once confirmed and extended these observations of Stas, and our results may be of interest as showing that in the very familiar method of determining chlorine by precipitation with nitrate of silver, which is generally supposed to be extremely accurate, a sensible error may arise from the solubility of the chloride of silver in the hot distilled water used in washing the precipitate. It would be well for every analyst to make the following very striking experiment, which will enable him to appreciate the extent of the action in question.

Take from 5 to 10 c.c. of pure hydrochloric acid, and precipitate the chlorine in the usual way with nitrate of silver, avoiding a large excess. After pouring off the supernatant liquid and washing the precipitate once or twice with cold distilled water, pour upon the white flaky chloride of silver a comparatively large volume of boiling water. As soon as the precipitate settles, pour off the clear hot water, dividing the solution between two precipitating jars. To one of these add a few drops of a solution of nitrate of silver, and to the other a few drops of hydrochloric acid. In both cases a precipitate of chloride of silver will fall, and most chemists, certainly, will be surprised at the effect; for it is not a mere turbidness that results, but a well-defined precipitate, whose amount is easily estimated. Successive portions of boiling water poured upon the precipitate give the same reaction. In one experiment the reaction was still perceptible in the fourteenth wash-water. But under the action of the boiling water the precipitate becomes crystalline or granular, and the action lessens, until at last the water does not dissolve sufficient chloride of silver to cause even a cloudiness on the addition of nitrate of silver, as just described. Mr. G. M. Hyams, a student in this laboratory, washed two different portions of chloride of silver with boiling water until the action ceased, and then weighed and examined the residue. In the first experiment 1·4561 grms. of chloride of silver were washed with 66 litres of water. The chloride of silver was then collected, and found to weigh 1·2320 grms. Hence 0·2241 grm., corresponding to 15·39 per cent, had passed into solution. In the second experiment 60 litres of water were used, and 16·03 per cent of the chloride of silver originally precipitated were dissolved. These numbers, however, are only approximately accurate, for as the precipitate becomes granular it settles with less readiness, and there was necessarily some loss in filtering off so large a volume of liquid.

In the experiments above described the boiling water produced only a very slight decomposition of the chloride of silver. The precipitate, granulated by the washing, readily dissolved in aqua ammonia, leaving less than a milligramme of black powder, which was proved to be metallic silver.

The solvent power of water on freshly precipitated chloride of silver did not appear to be influenced by the presence of free nitric acid, even in large quantities. We tried the effect both of dropping the nitric acid on the precipitate before pouring on hot water, and also of previously adding nitric acid to the boiling wash-water. We used amounts of nitric acid ($\delta = 1{\cdot}355$) varying from 5 to 200 c.c. to the litre of water, but without finding any marked difference in the result.

The presence of a small amount of nitrate of silver in the water entirely prevented its solvent action, so far as we could discover. In order to determine the limit of the action, we added different quantities of nitrate of silver to the boiling water before pouring it on to the precipitated chloride of silver. With 1 centigramme of nitrate of silver to the litre of water there was a marked turbidness on subsequently adding an excess of the same reagent to the filtrate. With 2, 3, or even 4 centigrms. to the litre an opalescence could still be distinguished, although constantly diminishing with the increasing amount of the salt. With 5 centigrms. there was no opalescence, and we concluded that 1 decigrm. of nitrate of silver to the litre of boiling wash-water would certainly prevent all action.

A few drops of hydrochloric acid added to the wash-water greatly diminishes its solvent action on flaky chloride

* "Metallurgy of Silver and Gold," Part I., p. 60.

of silver, but does not wholly prevent it, as is evident from the fact shown in the table below, that hydrochloric acid does not precipitate chloride of silver from its solution in water nearly as effectually as nitrate of silver; and, as is well known, hydrochloric acid, if in any considerable excess, exerts a strong solvent action on the precipitated chloride.

As shown by Stas, the precipitation of chloride of silver, from its solution in hot water by the reagents we have named, depends solely on the change which the reagents produce in the solvent. That the action is an example of simple solution is shown by the fact that a considerable portion of the chloride of silver dissolved in boiling water is deposited when the solvent cools. This phenomenon is a striking one, and can easily be observed by pouring into a glass crystallising pan some of the clear solution obtained in the experiment described above. As the water cools it becomes cloudy, and deposits a granular powder, which adheres to the bottom of the glass. The grains are usually very small; but if the solution cools slowly the crystalline form can readily be distinguished under the high powers of a good microscope, and the little cubes present all the characteristics of the native crystals of chloride of silver. It is evident, therefore, that the granular condition of chloride of silver is a crystalline condition, and this experiment may elucidate the manner in which the native crystals are produced.

We have thus far only spoken of the solubility of chloride of silver in boiling water. As is evident from the crystallisation just described, the solubility rapidly diminishes as the temperature falls; but even at the ordinary temperature the solubility is distinctly marked. Lukewarm water poured on and off freshly precipitated chloride of silver becomes decidedly opalescent on the addition of nitrate of silver, and even if cold water is used the opalescence is perceptible.

In order to obtain an approximate measure of the effects we have described, Mr. Hyams precipitated about 15 grms. of chloride of silver, and, after thoroughly washing it, boiled the precipitate with a large volume of water in a glass flask. At the end of an hour he decanted through a filter about 1 litre of the boiling water, and, having divided the filtrate into two portions, he added to one portion nitrate of silver, and to the other hydrochloric acid. The precipitated chloride of silver was in each case collected and weighed. At the end of two hours' boiling, two other portions were filtered off and treated in a similar way. These determinations were then repeated with a fresh quantity of chloride of silver, and afterwards taking a third quantity of chloride of silver, the boiling water was simply poured on twice in succession, and the similar portions thus obtained treated as before. The results in every case were nearly the same as shown in the following table. In this table—

1 and 2 are results after 1 hour's boiling of 1st quantity.
3 and 4 " " 2 hours' " "
5 and 6 " " 1 hour's " 2nd q'tity, &c.
7 and 8 " " 2 hours' " " "
9 and 10 after simply pouring on boiling water.
11 and 12 " " "

No.	Weight of Water.	Weight of AgCl.	Weight of AgCl per litre.	Precipitant.
1	523·6 grms.	0·0011	0·0021	Nitrate of silver.
2	469·5	0·0004	0·0009	Hydrochloric acid.
3	115·0	0·0002	0·0017	Nitrate of silver.
4	402·1	0·0004	0·0010	Hydrochloric acid.
5	225·0	0·0004	0·0018	Nitrate of silver.
6	462·0	0·0004	0·0009	Hydrochloric acid.
7	696·4	0·0014	0·0020	Nitrate of silver.
8	825·4	0·0007	0·0008	Hydrochloric acid.
9	700·4	0·0014	0·0020	Nitrate of silver.
10	747·2	0·0007	0·0009	Hydrochloric acid.
11	520·9	0·0011	0·0021	Nitrate of silver.
12	287·5	0·0003	0·0010	Hydrochloric acid.

If we assume that the amount of chloride of silver precipitated by nitrate of silver under the conditions described above is a correct measure of the solubility of the chloride, it appears from the above determinations that about 2 m.grms of chloride of silver are dissolved by each litre of boiling water, and, further, that only about one-half of the amount thus dissolved is precipitated by hydrochloric acid.

In making chlorine determinations it is a very common practice to wash with very hot water, in order to secure the prompt settling of the chloride of silver, or to wash away any occluded material; and it was the chief object of this investigation to determine the extent to which the solubility of the chloride in distilled water might affect the result. For this purpose we made two series of determinations of the chlorine in chloride of antimony; in both cases precipitating with nitrate of silver the chlorine from a solution of the chloride of antimony in tartaric acid and water, with the usual precautions. But, while in the first series the precipitated chloride of silver was washed with boiling hot distilled water to about the 1-100,000th according to Bunsen's scheme, in the second series, although hot water was also used in washing, 1 decigrm. of nitrate of silver per litre was added to each successive portion of the wash-water poured upon the precipitate, until the last two portions, which were poured on cold. By this simple device the advantages of washing with hot water may be secured, while its solvent action is prevented. The results are given in the following table:—

First Series.

No.	Weight of $SbCl_3$ taken.	Weight of AgCl obtained.	Per cent of Cl calculated.
1	2·3856 grms.	4·4784 grms.	46·441
2	3·1300	5·8712	46·407
3	3·4207	6·4243	46·462
4	5·0031	9·3790	46·377
		Mean value	46·422
		Max. diff. from mean ..	0·047

Second Series.

No.	Weight of $SbCl_3$ taken.	Weight of AgCl obtained.	Per cent of Cl calculated.
1	3·4059 grms.	6·4188 grms.	46·624
2	3·6603	6·9014	46·643
3	2·4762	4·6658	46·617
4	2·5567	4·8212	46·651
		Mean value	46·634
		Max. diff. from mean ..	0·017

Difference between means of two series, 0·212

It is evident from these results that when great accuracy is required the solubility of chloride of silver may become a very serious source of error in determinations of chlorine, and in our first paper on the atomic weight of antimony this was the chief cause of the discrepancy between the analyses of chloride of antimony on the one hand, and the bromide, iodide, and sulphide of antimony—analyses of which closely agreed among themselves—on the other hand. It was shown in the paper just referred to that, although the greatest care was taken in purifying the material, the chloride of antimony used actually left behind, on evaporation, a sufficient amount of oxychloride to reduce the per cent of chlorine 0·116 (*loc. cit.*, p. 64). The mean results which we actually obtained from seventeen analyses of chloride of antimony was 46·620; and when to this we add 0·212 and 0·116, the sum is 46·948, which differs from 46·985—the theoretical value when Sb = 120. and Cl = 35·457—by only 0·037, or, if we take Cl = 35·5, by 0·072. In this estimate we leave out of the account the known solvent action on chloride of silver of the tartaric acid used to keep the antimony in solution. This must equally affect both of the series of determinations given above, and fully accounts for the small difference that re-

mains to be explained. This whole discussion, however, only serves to confirm the conclusion previously expressed, that chloride of antimony is a most unsuitable material for the basis of an atomic weight determination; and, having explained the anomaly to which we gave prominence in a previous paper, we shall here take leave of the subject. We have also studied the solubility of bromide of silver in water, but this is so small that we found it difficult to measure the amount. In water at the ordinary temperature, or even in tepid water, bromide of silver is practically insoluble. In boiling water it is perceptibly soluble, but not more so than is chloride of silver in water at the ordinary temperature. Hence the determination of bromine does not require the same precautions, and is susceptible of greater accuracy than that of chlorine; and on this account, as well as for other reasons which we have previously discussed, the atomic weight of antimony can be deduced from the analyses of the bromide of antimony with as great accuracy as can at present be reached in such determinations. In the seven determinations of the per cent of bromine in bromide of antimony, whose results are given beyond, the maximum difference from the mean value 66·6651 was only 0·0045, and Prof. Mallet, in his analyses of bromide of aluminum, has obtained with the same method a similar degree of accuracy.*

In conclusion, we would again express our obligations to Mr. G. M. Hyams, who has assisted us in the work of this investigation.

(To be continued.)

* *Phil. Trans.*, Part III., 1880, 1022.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 3, 1881.

Dr. GILBERT, F.R.S., Vice-President, in the Chair.

DR. GILBERT mentioned that the President, Dr. Roscoe, was unavoidably absent, having been appointed by her Majesty on the Royal Commission on foreign technical instruction. The minutes of the previous meeting were read and confirmed. The following certificates were read for the first time:—C. Armitage, D. E. Anatole, C. H. Bothamley, J. Bingley, T. Farmer, R. P. Gardner, H. E. Head, W. B. Harrington, J. Innes, W. Jackson, R. V. Jackson, P. S. Looker, R. T. Mathews, K. D. Naegamvala, J. B. Orr, H. Ross, C. H. Sieber, C. H. Slaytor, R. Tervet, J. S. Topham, Rev. E. W. V. Volckxson, C. Wilkinson, J. Whitlock.

The SECRETARY then read a paper "*On Citraconic and Mesaconic Ethers, and Maleic and Fumaric Acids*," by W. H. PERKIN. It has been shown (*Journ. Chem. Soc.*, 1881, 409) that the differences existing between α- and β-coumaric acids are comparable to those between maleic and fumaric, and again between citraconic and mesaconic acids. Petri has pointed out a fresh point of resemblance between the two latter acids, and has found that as α-methyl-coumaric acid when distilled with phosphoric chloride yields the chloride of the β acid, so citraconic acid yields the chloride of mesaconic acid. A considerable divergence exists in the boiling-points, for, while the ethers of the α-coumaric acid boil at lower temperatures than those of the β acid, the ethers of maleic and citraconic acids boil at higher temperatures than those of fumaric and mesaconic acids. The author thought it desirable to compare some other physical properties. The methylic ethers of citraconic and mesaconic acids were first selected. The details of their preparation are given in the paper. The results obtained were:—Methylic citraconate boils at 212°, sp. gr. 1·1168, magnetic rotatory power 1·064; methylic mesaconate boils at 205°, sp. gr. 1·1254, mag. rot. power 1·154. The ethylic ethers gave ethylic citraconate boils 231·75°, sp. gr. 1·050, mag. rot. power 1·121; ethylic mesaconate boils 229°, sp. gr. 1·051, mag. rot. power 1·168. Dr. Gladstone has determined the refractive indices and finds the mesaconate in both cases more dispersive than the citraconate. The author endeavoured to prepare from fumaric acid an anhydride other than maleic acid, by the action of fumaric chloride on argentic oxalate, on argentic fumarate, on argentic carbonate, and by the action of acetylic chloride in the presence of acetic acid on fumaric acid, but in all these reactions maleic anhydride was alone obtained. So that it appears that there is but one anhydride for maleic and fumaric acids, one anhydride for citraconic and mesaconic acids, and one anhydride for α- and β-coumaric acids. The author then discusses the cause of the isomerism of these acids, and concludes that in the conversion of maleic acid, &c., into the corresponding isomerides, a contraction of the molecule takes place, attended with greater stability and diminished solubility. This conclusion is borne out by an examination of the aniline salts. The author then gives an account of a process for the direct preparation of maleic anhydride from malic acid. By heating malic acid with an excess of acetylic chloride in a water-bath, a transparent gummy fluid was obtained, which on distillation yielded a large quantity of pure maleic anhydride; the yield was from 40 to 48 per cent.

Mr. M. M. P. MUIR then communicated several papers. The first was "*On the Action of Potassium Cyanide on Bismuthous Nitrate.* By the above action Boedeker obtained a reddish brown salt, to which he gave the formula $Bi_2O_52H_2O$. In a previous paper the author prepared this puce coloured body, and came to the conclusion that it contained no water when dried at 150°, and that its composition was Bi_2O_7. Subsequent and more careful testing of this substance has convinced the author that it contains cyanogen, and that its formula is $Bi_7(CN)_6O_{15}$, or, perhaps, $2Bi(CN)_55Bi_2O_5$. This bismuth oxycyanide when dried at 140° to 150° is a reddish brown solid, somewhat resembling lead dioxide; it dissolves in hot strong nitric or sulphuric acid, producing dark red liquids. The author gives details as to the formation and reactions of this substance. By the action of hot concentrated aqueous potash on the oxycyanide Bi_4O_7 is formed. This compound, which the author designates bismutho-hypobismuthic oxide, is heavy, dark grey, and crystalline; it undergoes no alteration when exposed to air and light; dissolves readily in strong hot nitric acid, forming a purple liquid.

"*On the Atomic Weight of Bismuth*," by M. M. P. MUIR. Dumas, by the determination of the chlorine in bismuthous chloride, found the atomic weight of bismuth to be 210·44. Schneider, by converting known weights of bismuth into the nitrate, igniting, and weighing the oxide, came to the number 208·005. Re-calculating these numbers with the more recent atomic weights, we have Dumas's at. wt. 209·86, Schneider's at. wt. 207·5. The author has for some time been engaged in revising the atomic weight of bismuth, but states that his results so far are more negative than positive. He gives some results in the present paper obtained by the analysis of bismuthous chloride: determining the chloride volumetrically (full details of the method are given), he obtained a mean number 211·58; gravimetric analysis indicated 209·35; mean 210·46. The differences between the various numbers are, however, too considerable, and the author hopes to obtain better results by the synthesis of bismuthous iodide.

"*Additional Observations on the Halogen Salts of Bismuth*," by M. M. P. MUIR. The author has studied the effect of varying strengths of the haloid acids on Bi_2O_3. The reactions with the various acids resemble each other, but the actions with hydriodic and hydrofluoric acids are modified by the greater insolubility and stability towards water of the bismuthous iodide and fluoride, so that very dilute hydriodic acid must be used to ensure the formation of BiOI, whilst the Bi_2O_3 must be boiled

with HF to transform all the bismuthous oxide into the oxy-fluoride; probably, also, the formation of double salts, $BiF_3,3HF$ and $BiOF,2HF$, modifies the reaction.

"*Note on the Action of Sulphuric Acid on Zinc and Tin*," by M. M. P. MUIR and C. E. ROBBS. Strong sulphuric acid, $7H_2SO_4+2H_2O$, exerts no action on zinc until a high temperature is reached, when SO_2 is evolved, and some sulphur separates; more dilute (7 : 4) acts similarly; with acid still more dilute (1 : 1) no SO_2 is produced, but H_2S is evolved with the separation of sulphur. With weaker acids the action begins at a lower temperature, and hydrogen is the chief product of the reaction. Traces of sulphuretted hydrogen also come off, but no SO_2 and no S. The action of strong sulphuric on tin at ordinary temperatures is very slight, SO_2 being evolved and a little sulphur; as the temperature rises the action increases, and H_2S begins to appear. With acid 1 : 1 (molecules) H_2S is evolved at a lower temperature, and at 120° H, H_2S, SO_2, and S are formed simultaneously; more dilute acids have but little action until the boiling-point is reached, when H and H_2S are evolved; with $H_2SO_4:7H_2O$, H alone is formed.

"*On the Volumetric Estimation of Bismuth in the Form of Oxalate*," by M. M. P. MUIR and C. E. ROBBS. This is a modification of the process of Von Reiss (*Berichte*, 14, 1172) to adapt it for volumetric purposes. The reaction is $Bi_2O_3+4K_2C_2O_4H_2O=Bi_2(C_2O_4)K_2C_2O_4+3K_2O+4H_2O$. The bismuth oxide is dissolved in a minimum quantity of nitric acid, the solution freed from excess of nitric acid by evaporation, and a large excess of acetic acid added. An excess of standard potassium oxalate is added in a measuring flask and the double oxalate of bismuth and potassium allowed to settle. An aliquot portion of the clear solution is drawn off and titrated with permanganate.

"*Note on the Influence of Water on the Reaction between Potassium Iodide and Chlorine*," by M. M. P. MUIR and R. THRELFALL. This action is carefully studied, and also the effect of suddenly arresting the action, and then allowing it to proceed. Curves and tables accompany the paper. This apparently simple reaction seems to be in reality very complex.

"*Laboratory Notes*," by M. M. P. MUIR.

a. A lecture experiment showing the effect of (*a*) time, (*b*) temperature, (*c*) mass was exhibited by the author. Three beakers, containing respectively 100 c.c. of cold water, 100 c.c. of water at 90° to 100°, and 500 c.c. of cold water, are placed on a white surface; to each a few drops of a solution of BiI_3 in HI are added. In the 1st beaker brown BiI_3 is precipitated; in the 2nd, red crystalline BiOI; in the 3rd, a smaller quantity of BiOI. The brown BiI_3 in the 1st is slowly converted into BiOI, but the reverse change can be produced by pouring some strong HI.

b. The solution of manganese dioxide and manganese ores in hydrochloric acid. The author has confirmed the observation of Pickering (*Chem. Soc. Journ.*, 1880, 128) that potassium iodide facilitates this solution. The rapidity of the action was doubled by adding an excess of KI.

c. A new method of detecting tin in the presence of antimony. The stannic salt is reduced to stannous by boiling with copper turnings for ten minutes, after dissolving the mixed sulphides in strong hydrochloric acid. The stannous chloride is recognised by the reaction with mercuric chloride.

d. To detect the haloid acids in presence of nitrous and nitric acids. Test for HI by CS_2 and N_2O_3; if present remove by adding to neutral liquid $CuSO_4+FeSO_4$ and filtration; boil filtrate with KIIO to precipitate Cu and Fe, filter, and test as under:—

Test for HBr by CS_2 and Cl water; if present, remove by adding H_2SO_4, and then $KMnO_4$, until purple; boil ten minutes; filter, test filtrate for HCl by $AgNO_3$.

Test for HNO_2 by adding acetic acid and $FeSO_4$; if present remove by adding to a fresh portion much solid AmCl, and evaporating till liquid s thick; dilute, and test for HNO_3 by $FeSO_4$.

Test for HClO by adding one drop of indigo solution, and then dilute HCl until acid; do not warm. Instant decolourisation indicates HClO; slow bleaching, with evolution of red fumes, is due to HNO_2. Remove HClO by boiling with H_2SO_4 until Cl is no longer evolved; cool add indigo solution and H_2SO_3; bleaching indicates $HClO_3$.

Mr. WARINGTON suggested the addition of a little urea to get rid of any nitrites; on boiling for two minutes all nitrites would be decomposed, whilst the nitrates would be practically untouched.

"*On Suberone*," by R. S. DALE and C. SCHORLEMMER. The work in this paper, so the authors state, was carried out by Dr. A. Spiegel, the authors only furnishing the material. The object of the investigation was to establish the constitution of suberone. Suberone, $C_6H_{12}CO$, was combined with hydrocyanic acid, yielding the cyanhydrin, $C_7H_{12}(HO)CN$. By the action of hydrochloric acid the body $C_7H_{12}(HO)CO_2H$ was formed; this was subsequently transformed successively into $C_7H_{12}Cl,CO_2H$, $C_7H_{11}CO_2H$, $C_7H_{13}CO_2H$. This last substance, suberan-carboxylic acid, was boiled with nitric acid, when a bibasic acid, having the formula $C_8H_{12}O_4$ or $C_8H_{14}O_4$, was obtained; further examination had to be postponed, on account of the want of a further supply of the expensive suberone.

"*On Sulphonic Acids derived from Isodinaphthyl*," by WATSON SMITH and T. TAKAMATSU. The authors have prepared and investigated the following bodies:—Dinaphthyl $\beta\beta$ mono-sulphonic acid, $C_{10}H_7C_{10}H_6SO_3OH$, its calcium and barium salts; also barium $\beta\beta$ dinaphthyl-disulphonate—

$$\left.\begin{matrix} C_{10}H_6SO_3 \\ C_{10}H_6SO_3 \end{matrix}\right\rangle Ba,$$

an isomeride, and the lead salt of this acid. The lead salt of $\beta\beta$ dinaphthyl-tetra-sulphonic acid was also prepared.

"*On Phenyl-naphthalen*," by WATSON SMITH and T. TAKAMATSU. The chief object of the authors was to increase the yield of this body, which is obtained by exposing a mixture of bromobenzene and naphthalene to a high temperature (*Ber.*, xii., 1396, 2049). The authors give an account of their improved process. The phenyl-naphthalene was obtained in beautifully white plates, melting at 101° to 102°. A vapour density determination gave 7·08.

"*On Dimethyl-malonic Acid and Dimethyl-barbituric Acid*," by L. T. THORNE. By the action of methylic iodide on the di-silver derivative of barbituric acid, Conrad and Guthzeit obtained a dimethyl-barbituric acid, which, on saponification with potassic hydrate, &c., yielded dimethyl-malonic acid, fusing at 185°. Markownikoff, however, who first prepared this acid, by the action of potassic cyanide on bromiso-butyric acid, and decomposing the resulting product with HCl, gives its fusing-point as 170°. To explain this discrepancy the author has prepared dimethyl-malonic acid by saponifying ethylic-dimethyl-malonate with caustic potash, &c. The acid so prepared fused constantly at 186°, but sublimes before fusion. The author prepared the zinc salt which crystallises with one molecule of water. It is clear, therefore, that the acid obtained by Markownikoff could not have been pure. To remove all doubt the author prepared some dimethyl-barbituric acid by the action of dimethyl-malonic acid and urea. The acid so obtained agrees in all respects with that described by Conrad and Guthzeit. The first two hydrogen atoms substituted in barbituric acid in the formation of its salts are undoubtedly those contained in the CH_2 group of the malonyl radical, and not those attached to the two nitrogen atoms.

The Society then adjourned to November 17th, when the following papers will be read:—"Aluminium Alcohols, their Products of Decomposition by Heat," by Dr. Gladstone and Mr. Tribe. "The Chemical Action of Decomposing Vegetable Matter on the Rock-forming Sediment of the Carboniferous Period," by E. Wethered.

NOTICES OF BOOKS.

City and Guilds of London Institute for the Advancement of Technical Education. Programme of Technological Examinations 1881 *to* 1882. Gresham College, London, E.C.

This prospectus contains the general regulations of the Institute. It appears that in most of the subjects the examinations will be in two grades: a lower, ordinary, or "pass" examination, and a higher for honours. In each grade, however, there are two classes. The lower grade is intended principally for apprentices and journeymen, whilst the higher grade is designed for foremen and managers. Candidates may enter, however, for either, and there is neither limitation of age nor fee payable. The benefits of the scheme are not confined to London. If a local committee undertakes to carry out the examination according to the rules of the Institute, such examination will be held wherever a class for the needful instruction is formed and a sufficient number of candidates present themselves. The acceptable local committee may be either the committee of any art or science school connected with the Science and Art Department, or any School Board, or any Local Examination Board in connection with the Society of Arts. But in special cases a special local committee may be accepted. It must not be supposed that instruction must necessarily be given, or that candidates must present themselves in all or in even a large part of the subject.

Of the 32 branches in which examinations may be held, no fewer than 18 are to a greater or less degree dependent upon chemical science. To wit: Alkali manufacture, bread-making, brewing, distilling (including the very incongruous subjects of coal-tar distilling and the manufacture of spirit); sugar; fuel; colours and varnishes; oils, illuminating and lubricating; gas manufacture; iron and steel manufacture; paper; pottery and porcelain; glass; dyeing (silk and wool); bleaching, dyeing, and printing (calico and linen); tanning; photography and electro-metallurgy.

In certain cases each subject is distinctly two-fold. Thus the candidate in coal-tar distilling, which includes the manufacture of the coal-tar products, will not be examined in the manufacture of gin and whiskey, and *vice versa*; a candidate in bleaching, dyeing, &c., may at his option be examined in silk-dyeing, wool-dyeing, or in cotton-dyeing and printing. The division here is, however, much less natural than in case of distilling, since piece-goods to be dyed have now frequently a cotton warp with a woollen, worsted, or silk weft, and latterly even the yarns themselves are often a mixture of animal and vegetable fibres.

The syllabus before us gives under each head a list of the main heads upon which the questions will be founded, and a list of the works of reference which intending candidates may usefully study. There is a general proviso to which attention must be drawn. Before a full technological certificate can be obtained, the candidate who is not otherwise qualified (under Rule 33), will be required "to have passed the Science and Art Departments' examination for the full certificate in the ordinary grade in the elementary stage at least, and for the full certificate in the honours grade in the advanced stage at least in two of certain science subjects." Of these subjects a list is given under each section, and, we must say, they differ in a manner not to be explained. Thus, for the full certificate in wool- and silk-dyeing, the candidate must have passed in two of the following: Machine construction and drawing, theoretical mechanics, applied mechanics, light and heat, inorganic chemistry, and organic chemistry. If we turn to calico-dyeing and printing, we find, in addition to the above subjects, acoustics and elementary botany. The presence of acoustics in this list we can only account for by a clerical error, since its use to the dyer or tissue printer is about on a level with that of heraldry, Botany, too, can scarcely be pronounced to have any direct bearing on the subject.

According to Rule 33 above referred to, the certificate of the Science and Art Department will be dispensed with if the candidate has taken a degree in any British university, or can show a certificate from a professor at any one of a number of colleges specified that he has attended instruction in the requisite science subjects, and has passed a satisfactory examination.

It will at once strike the reader that there are not a few important chemical manufactures which have been so far omitted; such as soap, starch, artificial gums, chemical manures, glues and sizes, blood albumen, &c. Some of these will doubtless in course of time receive their due share of attention.

We have great hopes concerning the results of the activity of the City and Guilds of London Institute. Two possible evils should, we beg to suggest, be carefully avoided: We must remember what we want is a practical, not merely verbal, acquaintance with the different subjects. To this end the examinations should be as far as practicable directed, so as to test the working knowledge, and the resources of the candidate. Secondly, we must beware of a feverish and enthusiastic energy at the outset, succeeded before long by mere indifference and routinism. In all matters connected with higher education we must adopt for our motto "unhasting, unresting!"

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 15, October 10, 1881.

Sounds Produced in a Telephonic Circuit during Storms.—G. de Lalagade.—Referring to the recent memoir of M. Thury, the author mentions that he had observed the same phenomena, not merely during storms, near or remote, but sometimes, though less frequently, during cloudy weather in winter, and even occasionally on fine days almost free from clouds.

Galvanometer with Angular Deviations Proportional to the Intensities.—A. Gaiffe.—The instrument is a horizontal galvanometer graduated in milliwebers; its multiplier frame is of an elliptical form. Its deviations are regular under two angles of 35°, representing 35 milliwebers on each side of zero.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., Heft 3.

Existence of Ozone in the Atmosphere.—E. Schœne.—From the *Berichte der Deutsch. Chem. Gesell.*

Researches on the Heat of the Ground.—Dr. von Liebenberg.—All air-dry soils at equal temperatures radiate heat equally. The author insists strongly on the injurious effect of any agency that lowers the temperature of the ground in spring, as reducing both the quantity and quality of the crop.

Manurial Experiments with Phosphoric Acid in Different Forms of Combination.—Dr. Fittbogen, Prof. Dietrich, F. Oldenburg, Dr. Birner.—The authors have compared the manurial action of superphosphates made from Mejillones Guano and from Lahn phosphorite with precipitated "Kladno-phosphate" (an aluminium phosphate) and with iron phosphate. The proportionate results for grain were:—Mejillones superphosphate 32, Lahn do. 12, precipitated phosphate 8, Kladno-phosphate 9, iron phosphate 10, whilst a check experiment without phosphoric acid gave 9. On doubling the doses,

the yield was approximately doubled in case of the Mejillones and the Lahn superphosphate, whilst with precipitated calcium phosphate, with Kladno and iron phosphate, there was little difference. The authors conclude that in sandy soils, such as were used in their experiments, only that part of the phosphoric acid which is soluble in water is utilised. Plants cannot, by the mere action of their roots, and without the co-operation of ground waters containing carbonic acid, extract any phosphoric acid from the insoluble phosphates.

Manurial Action of Gypsum on Lucerne.—V. Nanquette, Prof. Medicus, and M. Schell.—Gypsum has proved useful in the cultivation of lucerne, even on decidedly calcareous soils. (This agrees with the view of Prof. Ville.)

Comparative Manurial Experiments.—C. Nerger.—In the experiments tried a manuring, containing otherwise all the constituents of the crop (barley), but deficient in silica, gave the poorest results, being on a level with a plot totally unmanured.

Nutritive Value of Gelatin.—N. P. Oerum and Dr. Ditzel.—A dog weighing 11 kilos., was kept for three days fasting, and received then daily for 9 days 45 grms. gelatin and 200 c.c. water. The excretion of nitrogen in the urine during the fast was daily 2·385 grms., during the gelatin diet 7·105 grms. This latter quantity exceeded that present in the daily ration by 0·785 grm. Hence during the gelatin diet 1·600 grms. of the nitrogen of the system was economised, and accordingly the animal lost weight in a smaller proportion than when fasting. The experiment was repeated with an increase of the daily ration of gelatin to 50 grms., but the results were still in accordance with those of Voit that gelatin indeed economises albumenoids, but can never entirely cover the waste of albumenoids in the system, and has therefore a much lower dietetic value than albumen.

Lupin Disease in Sheep.—Dr. G. Liebscher and Prof. Kühn.—There exists a poison in lupins which produces a disease resembling jaundice. This poison is rendered harmless by steaming.

Determination of the Value of Cattle Foods.—J. König.—It is proposed to overlook the physiological value of the various articles and to be guided merely by the market prices. Hence the ratio of value between proteine, fat, and non-nitrogenous extractive matter, is assumed, not as constant, but as fluctuating from year to year.

Studies on Evaporation from Vegetables.—Dr. P. Sorauer.—Not susceptible of useful abstraction.

Researches on the Ripening of Cheese.—Dr. G. Musso, Dr. A. Menozzi, and N. Bignamini.—The quantity of true albumen suffers little change during ripening, but the double compounds of albumen with calcium phosphate are decomposed, yielding peptons and amides. Lactose undergoes both the mucous and the alcoholic fermentation.

Action of Diastase upon Starch Paste.—A. Herzfeld.—The final products are maltose and achroodextrin.

Society of Arts.—The first meeting of the One Hundred and Twenty-Eighth Session of the Society of Arts will be held on Wednesday, the 16th inst., when the Opening Address will be delivered by Sir Frederick J. Bramwell, F.R.S., Chairman of Council. Previous to Christmas, there will be four ordinary meetings in addition to the opening meeting. For these, the following arrangements have been made:—November 23, "The Storage of Electricity," by Prof. Sylvanus Thompson, D.Sc.; November 30, Discussion on the Society of Arts' Patent Bill; December 7, "The American System of Heating Towns by Steam," by Capt. Douglas Galton, C.B., F.R.S.; December 14, "Electric Lighting at the Paris Electtical Exhibition," by W. H. Preece, F.R.S.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sulphuric Acid Test for Anthracen.—S. Baker will find the recognised test for anthracen, described by Meister, Lucius, and Brüning, in CHEM. NEWS, vol. xxxiv., p. 167.—W. W. STAVELEY.

MEETINGS FOR THE WEEK

MONDAY, Nov. 14th.—Society of Chemical Industry, 7.30. Address, by Prof. Abel. "The want of Uniformity in Tables of Specific Gravity," by Dr. Messel.

THURSDAY, 17th.—Chemical, 8. "Aluminium Alcohols: their Products of Decomposition by Heat," by Dr. Gladstone and Mr. Tribe. "The Chemical Action of Decomposing Vegetable Matter on the Rock Forming Sediment of the Carboniferous Period," by E. Wethered.

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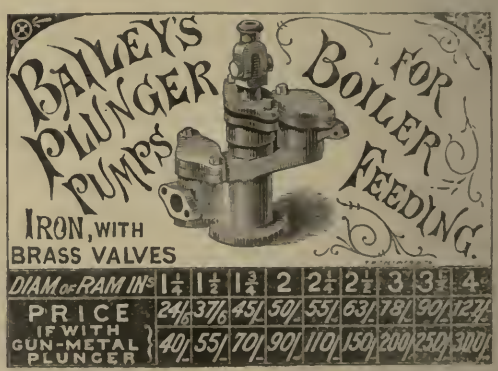

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1147.

ON THE OXIDES OF MANGANESE.*

By V. H. VELEY. B.A.

Part I.—Historical.

The oxides of manganese, though known to possess the peculiar property of clarifying crude glass, were not distinguished in earlier times by name (*Lapis Magnes*) from magnetic oxide of iron,† or some white mineral used medicinally.‡ But at a later period these compounds were designated specially by the titles of Magnesium nigrum or Magnesia vitrariorum. However, it was only at the end of last century that the researches of Pott (1740) and Kaim and Winterl§ (1770) established that oxide of iron was not a necessary constituent of the ores of manganese. Their properties and reactions were more completely studied by Scheele‖ (1774), who to some extent traced out the analogy between the so-called manganese and the metallic oxides. In connection with these experiments, Seven Ruiman¶ observed that black manganese, when heated in an assay furnace, was changed to a brownish red colour, without thereby becoming essentially altered in its properties. It does not, however, appear that this phenomenon attracted any attention until John** (1807) not only isolated the metal, but described and analysed three separate oxides—black oxide, or the natural product; green oxide, obtained by the oxidation of the metal in water; and brown oxide, by heating the two former oxides in the air. To these three oxides Berzelius and Arfvedson†† (1813-1817) added a fourth or less oxygenated black oxide, and these results were subsequently confirmed by Forchammer‡‡ (1820-1821), Berthier§§ (1821), and Turner‖‖ (1828). Berthier assigned to the free oxides their present formula, MnO, Mn_2O_3, Mn_3O_4, and MnO_2, and considered the two intermediate oxides to be compounded of the basic monoxide, MnO, with the acidic dioxide, MnO_2. Three distinct hydrates of the dioxide were also analysed, viz., $4MnO_2H_2O$(Berthier), $2MnO_2H_2O$ (Berthier), and MnO_2H_2O (Forchammer). It appears thus far that chemical enquiry satisfactorily established:—1. That manganese forms with oxygen a series of definite oxides (other than those present in manganic and permanganic acids); 2. that manganese dioxide forms a series of hydrates.

But the particular conditions under which these several oxides are formed were not defined until 1859, when Schneider,¶¶ in the course of his determination of the atomic weight of manganese, observed that all its oxides, when heated strongly in a current of oxygen, were converted into the oxide Mn_2O_3. A few years later Dittmar,*** starting with the two facts ascertained,—that the oxides when heated in air were converted into the red oxide Mn_3O_4, and when heated in oxygen into the sesquioxide Mn_2O_3—investigated the question as to whether various mixtures of oxygen and nitrogen oxides are formed intermediate in composition between Mn_2O_3 and Mn_3O_4. It was, however, found that when the tension of oxygen was between 0 and 0·21 atmosphere the red oxide was formed, but with oxygen tension between 0·26 and 1 atmosphere the sesqui or black oxide was formed.

In no case was an oxide intermediate in composition between Mn_2O_3 and Mn_3O_4 formed; either a small quantity of the brown oxide was found mixed with the black, or *vice versa*. At about the same time Görgeu* (1862) and Rammelsberg described a series of derivatives of a manganous acid, $H_2O,5MnO_2$, in which the hydrogen is replaceable by potassium, calcium, or manganese itself. The manganese manganate was isolated by passing a current of chlorine through water in which manganese carbonate was suspended.

Within the last few years the action of reducing agents—as hydrogen, carbonic oxide, and carbon—has been made the subject of elaborate researches by Wright.† The main points established in connection with the present discussion seem to be the following:—1. When the higher oxides are heated only to moderate temperature in air, oxides intermediate between Mn_3O_4 and Mn_2O_3 are formed; 2. When the oxides are heated in hydrogen there are two definite stages of reduction, the one corresponding to the formation of Mn_3O_4, the other to the formation of MnO. (Wright also confirmed and extended an observation of Fresenius,‡ that the oxides of manganese, when prepared by methods in which the fixed alkalies take part, are always contaminated by appreciable quantities of the alkali combined with the oxides. This fact unfortunately renders at least doubtful conclusions derived from several researches of these oxides.)

Experiments by Pickering§ indicate that oxide containing a relatively large quantity of so-called available oxygen lost oxygen, while those containing a smaller quantity absorbed oxygen when heated in air to 100°, and both these "reactions increase in extent up to 200° to 250°." This loss or gain of oxygen seems to be dependent not altogether on the original amount of available oxygen, but also on the amount of water, combined or uncombined, present in the oxides.

Part II.—Experimental.

It seemed desirable to the author to study the higher oxides of manganese prepared so as to avoid contamination with alkalies, with regard to the changes which such oxides undergo when heated to moderate temperatures in various gases rendered as pure and dry as possible. The starting-point of the research was a hydrate of the oxide Mn_6O_{11}, isolated by Görgeu (*vide supra*).

Change in Air.—The hydrated oxide was heated in a current of air at temperatures ranging from 60° to 200° C. It was found that the oxide underwent two distinct changes—first, a loss of water of hydration; second, an absorption of oxygen, these changes between 130° to 150° being concomitant, and possibly dependent one on another. Thus, a hydrate of the oxide Mn_6O_{11} was converted into a hydrate of an oxide, $Mn_{12}O_{23}$. It was also observed that at certain temperatures the oxide neither lost water nor gained oxygen, owing to the production of a hydrated oxide stable at those temperatures. (For the experimental evidence on which these views are based the author must refer to a paper published in the *Journal of the Chemical Society*, 1880, 581-592.)

Change in Oxygen.—On repeating the experiments with oxygen substituted for air similar changes were observed, but, according to expectation, the absorption of oxygen begun at a lower temperature and the oxidation was more

* Read before the British Association, York Meeting, Section B.

† Pliny, Lib., 36, c. 16, 15. The early history of the chemistry of the oxides of manganese is given in Kopp's *Geschichte der Chemie*, iv., 82-89.

‡ Hippocrates, 54, 328.

§ De Melatus dubiis, 48.

‖ "Essays," 139.

¶ *Ibid.*

** *Gehlen's Journal für Chemie und Physik*, 3, 452.

†† *Schweigger. Journal*, 7, 76; *Ann. Chim. Phys.*, 6, 204.

‡‡ *Ann. Phil.*, 16, 130, and 17, 50.

§§ *Ann. Chim. Phys.*, 20, 186.

‖‖ *Phil. Mag. Ann.*, 4, 22, and 96.

¶¶ *Pogg. Annal.*, 117, 614.

*** *Chem. Soc. Journ.*, 17, 294.

* *Ann. Chem. Phys.*, [3], 56, 153. The acid nature of manganese dioxide has been further established by Weldon (Chemical News, vol. xxii., p. 145), but recently this has been criticised by Post (*Ber.*, 12, 1454, and 13, 50.

† *Journ. Chem. Soc.*, 1878 (1), 504; 1880, 23 and 775.

‡ *Zeit. Anal. Chem.*, 1872, 295.

§ *Journ. Chem. Soc.*, 1879, 659; Chemical News, vol. xliii., 189, *seq.*

complete. An oxide of composition expressible by a formula $Mn_{23}O_{45}xH_2O$ was obtained.

Change in Nitrogen.—In nitrogen the only change observable was a loss of water of hydration; the relation of manganese monoxide to oxygen was the same after as before the experiments. It thus appears that the changes in nitrogen at low temperatures is totally different from that in high temperatures (Dittmar, *vide supra*), in which is involved a loss of available oxygen.

Change in Hydrogen.—The author's results confirmed the former experiments of Wright: there were the two distinct changes of loss of water of hydration, and loss of available oxygen. At 200° a hydrate of an oxide approximating in composition to Mn_3O_4 was formed. The oxides and their hydrates are tabulated below, but in order to facilitate comparison and to show their mutual relations they are represented as peroxidised derivatives of a protoxide of molecular formula $Mn_{24}O_{24}$.

	$Mn_{24}O_{44}8H_2O$	$Mn_{24}O_{45}8H_2O$ (?)	
	$Mn_{24}O_{44}6H_2O$		
	$Mn_{24}O_{444}H_2O$	$Mn_{24}O_{463}H_2O$	
$Mn_{24}O_{323}H_2O$	$Mn_{24}O_{442}H_2O$	$Mn_{24}O_{462}H_2O$	$Mn_{24}O_{472}H_2O$

The author hopes shortly to bring forward further account of his experiments on these oxides.

With regard to the constitution of these bodies, it seems interesting to examine as to how far they can be regarded as true chemical entities. They must be either heterogeneous mixtures, or homogeneous mixtures, a so-called molecular compound, or, lastly, chemical compounds or entities. Their thorough uniform appearance under the microscope proves that these bodies are not heterogeneous mixtures. Again, although it is at least possible that a homogeneous mixture of two bodies might be prepared, of which one formed a series of definite hydrates, yet it is quite improbable that the relative quantities of water combined with the same weight of the mixture would bear any simple arithmetical proportion one to another. But the quantities of water combined with the same weight of one of the oxides were in the relation 1 : 2 : 3 : 4. It is generally received and promulgated in the text-books that all the manganese oxides are molecular combinations of the monoxide and the dioxide in various proportions. This view is based on an observation of Forchammer,* that the sesquioxide Mn_2O_3, when treated with nitric or sulphuric acid, is separated into the monoxide, which dissolves as manganous nitrate or sulphate, and the dioxide which remains undissolved. But it has never been established, and indeed is quite improbable, that by this reaction there is an exact and quantitative separation of the two oxides.

This view has also been furthered by the general tendency, since Kekulé's memoirs on molecular compounds, to reduce the formula of all inorganic non-volatile compounds to their simplest possible terms. But these hydrated oxides—not only at the temperature of their formation, but also at ordinary temperatures—are even more stable than the monoxide, which readily absorbs oxygen, or the dioxide which readily loses oxygen. If, then, the monoxide and dioxide be regarded as chemical entities, so equally these higher oxides must be regarded in the same light, if stability be considered to be the criterion of true chemical combination. The probability of the existence of these series of oxides and hydrates was further corroborated by a repetition of the experiments in which were obtained oxides of the same and not approximate composition which at the same temperature underwent the same cycle of changes. It is still of course an open question how far the formulæ above express the real molecular constitution of these oxides. There is some evidence in favour of regarding the molecules of the metallic oxides as complex,† and therefore the molecule of the oxide Mn_6O_{11} might be constituted as $Mn_{12}O_{22}$ or $Mn_{24}O_{44}$.* On the one hand, the fact of the oxide $Mn_{12}O_{22}$ forming hydrates containing 4, 3, 2, and 1 molecule of water of hydration, and in that it is converted, when heated in air, to an oxide $Mn_{12}O_{23}$, seems rather to point to these oxides as oxidised derivative of a monoxide expressible by a formula $Mn_{12}O_{12}$. On the other hand, the formation of an oxide $Mn_{24}O_{47}$ would seem to support the supposition that these oxides are derived from a monoxide of formula $Mn_{24}O_{24}$. At present the formula $Mn_{12}O_{12}$ seems to be supported by the greater preponderance of evidence.

The author proposes to carry on researches on oxides of other metals, and hopes thereby to arrive at a more intimate knowledge of their constitution.

(Note.—Since this paper was written, a series of researches on the hydrated oxides of tin and manganese has been published by Van Bemmelen, in which the author arrives at the conclusion that the affinity of the water molecules cannot be differentiated from so-called chemical affinity, inasmuch as these hydrated oxides decompose aqueous solutions of such stable compounds as potassium sulphate, chloride, or nitrate.)

* *Ann. Phil.*, 17, 50.

† *Vide* Lothar Meyer, "Die Modernen Theorien der Chemie," 3rd Auflage, 220–243.

* A somewhat similar complexity of oxides of tungsten has recently been noticed by Klein, *Bull. Soc. Chim.* [2], 36, 17-18.

† Abstract of a Paper read before the British Association, York, 1881.

THE BLOWING WELLS NEAR NORTHALLERTON.†

By T. FAIRLEY, F.R.S.E.

The term "blowing wells" has been applied because at certain times strong currents of air blow out from the shafts of the wells, while at other times equally strong currents blow into them. An examination of the sandstone rock in which the wells are sunk shows the fissures through which the air passes. It is also observed that an out-current prevails while the barometer is falling, an in-current while it is rising, and that when the barometer remains stationary for any length of time, the current slackens, and at length becomes perfectly still.

Having proved by analysis that the gas passing in these powerful currents was really atmospheric air, it seemed to me that the only possible explanation of the phenomena is the existence of large cavities in the strata communicating by fissures with the shaft of the wells, of course above the water-level. Applying the well-known law of the relation of the volume of gases to pressure, in virtue of which an increased pressure (indicated by a rise of the barometer) causes the volume of air in any confined space to become less, and a diminished pressure (indicated by a fall of the barometer) causes the volume to become greater than before, I thought it possible by measuring the air passing out or in during a period of fall or rise of the barometer, and by carefully observing the barometric changes, to obtain data by which the volume of these cavities might have become known approximately.

At present three of these wells are known in the district:—At Solberge, three and a half miles southward from Northallerton; another at Langton, about four miles W.N.W. from Northallerton, these two wells being about five miles apart, situated on the rising ground separating the valleys of the Wiske and the Swale. The third well is at Ornhams, about two miles south from Boroughbridge.

(The analysis of the air from the well at Solberge did not show any excess of carbonic acid.)

At Solberge, the residence of Mr. John Hutton, a large number of experiments have been made, and I am indebted to that gentleman's kindness in continuing the observations of the instruments in my absence, and in rendering all the assistance in his power.

A small vane anemometer from Mr. Davis, optician, of Leeds, was used in the first series of experiments to measure the linear velocity of the current, and the sectional area of the large pipe leading from the well in which the anemometer was placed being known it was easy to obtain the total volume of air passing. Selecting those periods of rise or fall of the barometer which lasted so long that the current due to them had apparently time to expend itself, results were obtained giving the total capacity of the cavity as about 11 millions of cubic feet. Afterwards experiments were made, using very large dry gas meters. Two of the largest meters at liberty at the time in the stock of the Leeds Corporation were connected with the shaft of the well, one to register the out-current, the other the air-current. The force and magnitude of the current was, however, so great that these meters were soon thrown out of gear. I am indebted to Messrs. Glover and Son, the meter manufacturers, of London, for the loan of two very large meters, capable of passing 3000 cubic feet per hour. Even these after a time were found to be insufficient. The results actually obtained with them give a total capacity of 10 millions of cubic feet. A chamber 217 feet in length, breadth, and height would have practically the same capacity.

The rocks in the district are red sandstone, under which is magnesian limestone. The latter comes to the surface near Ripon on the south, and near Darlington on the north, and in both cases numerous "pot-holes" show its cavernous character. It is probable that the cavities connected with these wells occur in the limestone communicating by fissures in the sandstone. I have visited and enquired about many other wells in the district sunk in the same sandstone, but the three I have mentioned are the only ones showing air- or gas-currents.

The waters in these wells were analysed, and were hard waters similar to those found in limestone districts. The red sandstone from Solberge contains 7 per cent of carbonates of lime and magnesia. The air-currents are very powerful, producing a loud hissing noise in passing through crevices. A buzzer formed of some inverted bottles, placed over a pipe from the well at Solberge, could be heard at a distance of a mile from the well. It is likely that there are other wells in the county of this character, and if so I hope that this paper may lead to their being recognised and reported.

Analysis of Water from the Blowing Well at Solberge, Northallerton. Sent by J. Hutton, Esq., June 12th, 1879. The water contains in grains per gallon:—

Chloride of sodium	4·1
Sulphate of lime	6·36
Carbonate of lime	16·24
Carbonate of magnesia	11·36
Oxide of iron and alumina	0·03
Silica	0·21
Organic matter, loss, &c. (by diff.)	0·34
Total solids by evaporation	38·64

Colour of the water in two-foot tube, very slight green tint. Hardness of the water before boiling 32·6°, after 8·4°, giving temporary hardness 24·2°, permanent 8·4°, total 32·6°.

Analysis of Sandstone taken near the Water-level from the Blowing Well at Solberge, near Northallerton, April*, 1880.

The stone when fresh is soft and friable. Strong hydrochloric acid applied to the stone disintegrates it with effervescence. An analysis of the stone, after partial drying by free exposure to the air, gave the following numbers:—

Moisture	1·25	by diff. 1·27
Silica	87·72	
Peroxide of iron (traces of alumina)	3·96	
Lime*	3·58	98·73
Magnesia*	0·32	
Carbonic acid*	3·15	
Sulphuric acid	trace	
Loss	0·02	
	100·00	100·00

* These give 7·05 per cent of carbonates of lime and magnesia.

* Fifteen yards below the surface, adjacent to one of the fissures through which air was passing.

REPORT OF THE COMMITTEE ON PHOTOMETRIC STANDARDS.

THE Committee on photometric standards was appointed by the Board of Trade to examine and report upon the different standards which have been proposed by Mr. A. G. Vernon Harcourt, by Messrs. T. W. Keates and W. Sugg, and by Mr. J. Methven, and also the standard which is now used for testing the illuminating power of coal-gas. It was shown by preliminary experiments that standard candles are not uniform in their illuminating power; the causes and range of their variations were therefore experimented upon. In 115 determinations a maximum variation of 22·7 per cent in illuminating power was found between two pairs of candles; all these experiments were made by one observer, working with one apparatus, and as uniformly as possible.

The lamp devised by Messrs. Keates and Sugg is intended to give the light of 16 standard candles when burning pure sperm oil with a two-inch flame from a circular wick. As a rule the light emitted was constant, but occasionally it was subject to sudden variations; therefore the Committee think that it falls short of the requirements of a standard of light.

Mr. Methven's system is exceedingly simple, but still it is not considered by the Committee to be sufficiently exact for the work required of it. The system consists in allowing only a particular part of a 3-inch coal-gas flame to pass to the photometer, the coal-gas used at the testing burner being the same as that tested.

With regard to Mr. Harcourt's standard air-gas flame, the Committee say it is exact and trustworthy as compared with the sperm candle. The extreme difference obtained by two observers in 19 different observations by Mr. Harcourt's method was 0·3 candle, or 1·8 per cent. They recommend that in official documents the light furnished by coal-gas should still be expressed in standard candles, and also that the use of the sperm candle should be discontinued, and for the future Mr. Harcourt's air-gas flame (as defined in the appendix to the report) should be employed instead.

The number of grains of sperm burnt per hour in a standard candle has undergone many alterations, and has been the subject of many discussions. In 1849 the Great Central Gas Consumers Company decided upon 131·5 grs. per hour. In 1852, Prof. Graham and Dr. Leeson recommended that this should be changed to 140 grs. In 1860, the standard consumption of sperm was fixed at 120 grs. per hour; this is the present standard. It is here stated that only two London firms at present make sperm candles of the kind prescribed by the Acts, namely Messrs. Langton and Bicknell, of Newington Butts, and Mr. T. G. Miller, of Westminster. Mr. Miller states in a letter written to the Committee that, in his opinion, the irregularity with which the candles burn is due to irregularity in the plaiting of the wick.

The Committee have made a large number of experiments on the consumption of sperm by candles having

different wicks, having from 18 to 23 threads in them. The results of four comparisons between candles from different packets of Miller's 21-thread candles, each comparison being the mean of 20 observations at intervals of one minute, show that the ratio between the illuminating power of two pairs of candles frequently alters by 6 or 7 per cent in less than one minute. In six instances the ratio altered more than 10 per cent within a minute.

The Committee find that candles are open to very grave objections when used as a standard source of light. They mention very aptly that, beyond the custom of candle makers, there is nothing in the Parliamentary definition of the present standard candle to limit the diameter of the candle.

The following is a description of Mr. Methven's standard burner, which consists of a Sugg's London Argand, burning coal-gas with a 3-inch flame, having in front a screen with a slit cut in it:—

"In front of the burner, between it and the photometer disc, is fixed a brass screen, with provision similar to that of an ordinary candle holder, for fixing it at the end of the photometer bar. The tube on which the burner is fixed is provided with a T-piece and union joint, to which can be attached a flexible tube from the ordinary service to the photometer, supplied with an ordinary micrometer cock and governor, to facilitate the adjustment of the height of the flame. The end of the tube is fixed on a stand, so that the whole may be lifted off the end of the bar at any time. A hole about one inch in height and one-quarter of an inch in width is cut in the screen, which will be found sufficient to allow an amount of light to pass through it equal in illuminating power to that given by two standard sperm candles." The principle of Mr. Methven's standard depends on the possibility of finding corresponding portions of the flames of gases of varying qualities consumed so as to effect perfect combustion in similar burners, which shall be equal in illuminating power.

Experiments were made with different gases, such as pure Cannel gas, and Cannel diluted with varying quantities of common gas. The result of these experiments showed that while the light from the 37 candle gas was nearly equal to that from the 16¾ candle gas, with intermediate qualities of gas, the burner gave more light, the slit being in the same position throughout.

Mr. Vernon Harcourt's standard air-gas flame is produced by burning a mixture of air, with that portion of American petroleum which after repeated rectifications distils at a temperature of about 50° C. It is almost entirely composed of pentane; the proportion used is 576 volumes of air to one of pentane, measuring the liquid at 60° F.; the diameter of the burner is a quarter of an inch, and the height of the flame is brought to 2¾ inches. Several experiments on illuminated power were tried with samples of air-gas made on different days, and the results were found to be very concordant, the greatest difference between two observers being 0·2 of a candle. Other experiments were tried to find the effect of making a too rich or a too poor air-gas, and it was found that, taking the illuminating power of the normal mixture to be 100 candles, if 2·9 cubic feet of air were taken instead of 3, the illuminated power was equal to 100·53 candles, and if 3·1 cubic feet of air were taken to the same quantity of pentane, the light emitted was equal to 99·65 candles. The error in the volume of air being at least ten times greater than that likely to be made by any operator, it will be seen that the light will not be subject to much variation in intensity. All the experiments made with the air-gas flame being very satisfactory, the Committee have judged it to be the best standard for comparison.

Researches on the Formation of Starch Granules.—A. F. W. Schimper.—In the stems of many plants the starch granules do not arise at arbitrary points in the chlorophyl grain, but exclusively close under its surface.—*Biedermann's Central-Blatt.*

ANALYSIS OF SOIL FROM CUTTACK, BENGAL.

By C. J. H. WARDEN, Bengal Medical Staff, Chemical Examiner to Government.

The soil to which the following analysis refers was stated to have been obtained from the District of Cuttack, where the waters of the Orissa Canals are used for irrigation. The sample consisted of portions of earth taken from the surface, and from depths varying between 8 inches and 1 foot below the surface.

The soil was of a light fawn colour, and contained abundance of sand, but was free from stones or gravel. Particles of mica were visible, as well as a few small fragments of vegetable fibre. The specific gravity was 2·5, and it was found capable of holding 39·8 per cent of moisture. 100 parts contained:—

Ferric oxide, Fe_2O_3	5·7498
Aluminic oxide, Al_2O_3	6·1355
Calcic ,, CaO	0·3197
Magnesic ,, MgO	0·2350
Manganese	traces
Potassic oxide, K_2O	0·0768
Sodic ,, Na_2O	0·0497
Silicic oxide and sand, SiO_2	82·8100
Sulphuric anhydride, SO_3	0·0038
Phosphoric ,, P_2O_5	0·0013
Carbonic ,, CO_2	0·2513
Chlorine, Cl	0·0012
Nitrogen, N	0·2864
Non-nitrogenous organic matter	1·4489
Moisture	1·8143
	99·1837

The reaction was neutral; nitrates could not be detected. The whole of the iron was in the ferric condition.

Medical College, Calcutta, Sept. 6, 1881.

UPON THE

ADULTERATION OF FOOD, DRINK, AND DRUGS, FROM THE CHEMIST'S STANDPOINT;

AND UPON

THE ATTITUDE OF CHEMISTS IN THE MATTER OF APPOINTMENT OF "GOVERNMENT ANALYSTS."

By ALBERT R. LEEDS.

(Abstract).

The subject of adulteration had not received that amount of attention from the chemists which its nature and amount, as at present practised in the United States, properly demanded. And in neglecting to assume control of the investigation of the subject, and of the information and education of the public mind as to the actual facts, they had left the field in the possession of scientific demagogues and pseudo chemists who, for the past four years, had been sending out through the daily press an unlimited amount of sensational literature, either in part or altogether false. The investigations as to the facts had been mainly fragmentary and sporadic in their character, instituted from time to time by various Boards of Health, but without much outcome in the arrest and prosecution of the offenders. But this period of education had now gone by, and the time had come when the various States were about to pass laws upon adulteration. Some laws had been already enacted, and grave blunders had been committed. The experience in England had shown how difficult it was to secure wise and efficient legislation, and it was very important for chemists in America to avail

themselves of that experience, and to control and shape the laws now under consideration in the legislatures of the various States. Moreover, the duty of the public analyst required public training and accurate knowledge of certain topics not ordinarily studied by chemists. Finally the analysts could not properly perform their labours without the aid of suitably qualified inspectors, and as yet these two professions did not exist in the country and would have to be in a sense created.

Dr. Leeds, who had been commissioned by the State of New Jersey to investigate the facts concerning adulteration, as a basis for future State legislation, then gave a brief *resumé* of the results of his labours up to date. He had analysed a very large number of samples, and without claiming that the facts were universally true for the whole country, yet the examinations of so many articles of each kind, purchased at random from dealers in various parts of New Jersey and in the City of New York, might justly be regarded as representing a reasonably close approximation to the true facts in the case.

In regard to teas, three classes of adulterated samples had been found. The smallest class contained an amount of mineral matter in excess of that which should be present from facing materials alone, or from impurities which could properly be derived from the processes of preparation for the market. The largest class consisted of teas adulterated with exhausted leaves. Finally, in some samples foreign leaves were present in such numbers as to denote intentional adulteration. But the percentage of adulterated teas was much smaller than was anticipated (10 per cent), a majority of the teas being of inferior grade, their prices ranging from thirty to fifty cents per pound. Nearly all the coffees examined, both whole and ground, were pure; the adulterant in the other cases being chicory. The essences of coffee sometimes contained scarcely any coffee—one sample was composed almost entirely of chicory, caramel, and liquorice.

The manufacture of mixed sugars, containing both cane sugar and glucose, is now largely carried on in the United States, the product being sold under the name of "new process" sugar by the manufacturers. This fact had given rise to a popular belief that almost all varieties of sugar were more or less adulterated. Such was not found to be the case, most of the white sugars, purchased at random, being found pure; and of the brown sugars, which were the more adulterated, certain samples furnished by dealers as in their belief adulterated, were found to contain no more inverted sugar than might properly be present in a sugar of a low grade. A similar remark applies to the syrups. Even the lowest priced syrups were found, with few exceptions, to contain no more glucose than was to be expected in a non-adulterated article. No free sulphuric acid, or excess of lime, was present in any case.

The specimens of flour examined were uniformly pure, no other meal or alum being found in any instance. In bread, however, sufficient samples showing the employment of alum were obtained to demonstrate its occasional use by bakers. Cream of tartar was found to be extensively adulterated, the adulterants being sulphate of lime, acid phosphate of lime, and starch. The first-named substance was likewise present in some samples of bicarbonate of soda.

Some of the manufacturers of the baking powders now so extensively sold use only bicarbonate of soda, cream of tartar, and starch. Others employ either partly or altogether, in the place of the cream of tartar, alum or acid phosphate of lime, or a mixture of these two salts. Of the condiments and spices very few were pure, though in no instance was any injurious metallic adulterant detected.

Many of the samples of vinegar contained a much lower percentage of acetic acid than should have been present, but in no case were mineral acids present, and in only one instance a metallic substance—lead in traces. Some of the so-called white wine vinegars had all the characters of ordinary cider vinegar, decolourised by filtration through animal charcoal. None of the green pickles examined were free from copper—one pickle containing 15 milligrms. —although the pickles prepared by the use of brine, and those imported, with the Crosse and Blackwell label, were found unexceptionable. The employment of tin cans in the preservation of vegetables is reprehensible, both tin and lead being present in the canned tomatoes examined. The skimming and watering of milk was still very extensively practised in New York and New Jersey, although stringent laws had been passed for its repression.

Condensed milk varied remarkably in composition, the percentage of water ranging from 25·5 to 59 per cent, and of fat from 3 to 11 per cent.—*Journal of the American Chemical Society.*

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.*

By JOSIAH PARSONS COOKE, Director.

(Continued from p. 233.)

IV. Additional Experiments on the Atomic Weight of Antimony.

In our previous paper on this subject, we gave our reasons for the opinion, since fully confirmed, that the bromide of antimony is the most suitable compound of this element as yet known for determining its atomic weight; and the results of fifteen analyses of five different preparations of the bromide were published, which gave for the atomic weight in question the mean value 120·00, with an extreme variation between 119·4 and 120·4 for all the fifteen analyses, and between 119·6 and 120·3 for the six determinations in which we placed most confidence. The antimonious bromide used in these determinations was purified first by fractional distillation, and secondly by crystallisation from a solution in sulphide of carbon. In the crystallised product thus obtained, the bromine was determined gravimetrically as bromide of silver in the usual way. Although it seemed at the time that the results were as accordant as the analytical process would yield under the unfavourable conditions, which the presence of a large amount of tartaric acid in the solution of the bromide of antimony necessarily involved; yet it was obvious that the agreement was far from that which was desirable in the determination of an atomic weight, and our chief confidence in the accuracy of the mean value—independently of its remarkable agreement with previous results—was based on the fact that the known sources of error tended to balance each other. Hence our conclusions were stated with great caution, and the hope was expressed that, after a thorough investigation of the subject, we might be able "to return to the problem with such definite knowledge of the relations involved as will enable us to obtain at once more sharp and decisive results then are now possible."

In our previous paper, we described a simple apparatus which we devised for subliming iodide of antimony; and in a note to the paper we stated that we were applying the same process to the preparation of bromide of antimony, and that it promised excellent results. Our expectations in this respect have been fully realised, and the product leaves nothing to be desired, either as regards the beauty or the constancy of the preparation. The fine acicular crystals are perfectly colourless, and have a most brilliant silky lustre. With ordinary precautions, they can be kept indefinitely without change, and it is easy therefore to determine the weight of the material analysed to the tenth of a milligramme.

The material used in the following determinations was first prepared as described in our previous paper. It was then repeatedly distilled from a small glass retort, rejecting at each distillation the first and the last portion. Lastly,

* Presented to the American Academy of Arts and Sciences, May 11, 1881.

it was twice sublimed in a slow current of absolutely dry carbonic dioxide. As it was only possible to sublime a few grammes at a time in the apparatus we used, and as the several procucts were not mixed, each of the portions analysed was the yield of a separate sublimation, and the agreement of the results is therefore in itself a proof of the constancy of the preparation. In the first set of analyses, the bromine was determined gravimetrically by precipitation with nitrate of silver, as before described. The bromide of antimony was first dissolved in a concentrated solution of tartaric adid, using about 5 grms. of the crystallised acid to 1 grm. of bromide, and the solution was then diluted with from 250 to 500 cubic-centimetres of water. To this solution was slowly added, under constant agitation, a solution of nitrate of silver in slight excess of the amount required for complete precipitation. The amount of crystallised nitrate of silver required was always carefully weighed out, allowing 1 decigramme in excess of theory for every litre of the solution of bromide of antimony made as above described. The nitrate of silver was then dissolved in a considerable volume of water, and the bromide of silver was precipitated from a cold solution, care being taken to prevent the formation of lumps which invariably result if the solutions are warm or concentrated, and which greatly interfere with the washing of the precipitate. The precipitate was washed by decantation 5 times, pouring on in each case a volume of lukewarm distilled water equal to that of the original solution, and after the precipitate had settled, drawing off the wash-water with the inverse filter (see *Proceedings of the American Academy of Arts and Sciences*, vol. xii., page 124.) Lastly, the precipitate was transferred to a porcelain crucible and dried at from 120° to 130°.

The bromide of silver weighed was always tested, sometimes by dissolving the material in strong aqua ammonia, and at other times by heating it to the melting point. Had there been the least occlusion of silver emetic, or any other possible product, there would have been an insoluble residue or a loss of weight; and, since the bromide of silver always gave a perfectly clear solution, and the loss of weight on melting never exceeded a few tenths of a milligramme, we were assured that our product was perfectly pure.

Of the five determinations whose results are given below, the first three were made under my direction by Mr. G. De N. Hough; the last two were made with my own hands.

ANALYSES OF ANTIMONIOUS BROMIDE.

Determination of Bromine.

Wt. of $SbBr_3$ taken in Grammes.	Wt. of AgBr obtained.	P.c. of Br. Br=80 Ag=108.	Difference from Mean.	Value of Sb.	Diff. from Mean.
1. 4·1767	6·5420	66·652	−0·016	120·08	+0·08
2. 2·0250	3·1734	66·685	+0·007	119·90	−0·10
3. 1·9999	3·1340	66·680	+0·012	119·93	−0·07
4. 3·6985	5·7946	66·669	0·001	119·99	−0·01
5. 2·8959	4·5361	66·653	0·015	120·08	+0·08
Mean value		66·6679		119·996	
Theory Sb. 120 require		66·667			

The mean value of the percentage of bromine deduced from the fifteen analyses previously made (see *Proceedings of the American Academy of Arts and Sciences*, vol. xii., page 54) was 66·666, which differs only by an inappreciable quantity from the mean of the above results. At the same time the results are much sharper, the maximum difference from the mean value having been reduced to less than one-fifth of the previous amount, and to only 0·00025 of the quantity estimated, giving with certainty the atomic weight of antimony within one one-thousandth of its value. It must be remembered, moreover, that, although these last results were obtained with the same compound as before, the material was prepared in a wholly different way. The material first used was purified by repeated crystallisation from sulphide of carbon,—that last used by repeated fractional distillation and sublimation.

Hoping to reduce the limit of error to a still greater degree, we* were led to devise a volumetric method of testing the atomic weight of antimony, which, while it had all the advantages of the gravimetric method previously employed, is free from its sources of error. The method has also this great advantage, that it brings the question of the atomic weight of antimony down to a definite issue.

If the atomic weight of antimony were 122·00, it would require 1·7900 grms. of pure silver to precipitate the bromine from a solution of 2·0000 grms. of antimony bromide, while if the atomic weight of antimony were 120·00, it would require 1·8000 grms. of silver. Now it is easy to estimate volumetrically 1-100th of this difference with certainty. We therefore prepared with great care a button of *pure*† metallic silver, which we annealed, and rolled out to a thin ribbon. We then weighed out from 2 to 4 grms. of bromide of antimony, prepared by sublimation as described above, and dissolved this salt in an aqueous solution of tartaric acid, which we then transferred to a litre flask, and diluted to about 500 c.c. We next very accurately weighed out a quantity of silver, slightly less than that which calculation showed was required for complete precipitation. This silver was dissolved in nitric acid, and the solution having been evaporated to dryness over a water-bath, the silver salt was washed into the flask containing the bromide of antimony. As soon as the supernatant liquid had cleared, the small additional amount of a normal silver solution required to produce complete precipitation was run in from a burette, and measured with the usual precautions. We used no extraneous indicator, because it was important not to introduce any possibly new disturbing element into the experiment, and in the titration of bromine with silver, the normal and familiar phenomena, which mark the close of the process, furnish a very sharp indication. The details of one of the determinations were as follows:—

The weight of the bromide of antimony used amounted to 2·5032 grms. To precipitate the bromine from the solution of this material, 2·2404 grms. of silver would be required if Sb=122·00, and 2·2529 if Sb=120·00. We weighed out, with as much accuracy as if we were adjusting a weight, the smaller of these two quantities of metallic silver, and after dissolving the pure metal in pure nitric acid, evaporating the solution to dryness, and re-dissolving in water, we gradually added the whole of this silver solution to the litre flask containing the solution of bromide of antimony, in the manner described above. It was then found that 12·4 c.c. of a standard silver solution (1 grm. of silver to the litre) were required to complete the precipitation. It will be seen that the weights of the bromide of antimony and silver used could be thus determined with the most absolute precision, and we have the greatest confidence in these values to the

* Since publishing our "preliminary notice," our attention has been called to the fact that a similar process was used by Profesor J. W. Mallet of the University of Virginia in his investigation of the atomic weight of lithium, as it has since been used by him in his admirable work on the atomic weight of aluminum.

† A quantity of silver which had been reduced from chloride and bromide of silver, obtained as a product of previous analytical processes, was dissolved in nitric acid, and precipitated as chloride by hydrochloric acid. The precipitate was first boiled in *aqua regia*, and then thoroughly washed, after which the chloride was reduced by boiling with caustic soda and inverted sugar, and the precipitate, again washed, having been transferred to a porcelain crucible and dried, was heated to a low red heat in a muffle until the grains were sintered together. The sintered mass was melted on a block of prepared coke before a gas blowpipe, and while cooling was covered with a reducing flame in order to prevent the occlusion of oxygen gas. The metallic button was next rolled out into a ribbon between steel rollers; and, after the ribbon had been annealed in a muffle, the surface was etched with dilute nitric acid, and afterwards scoured with sand. The metal thus prepared was preserved under distilled water. The oxygen occluded by the metal thus prepared must have been, if any, exceedingly small in amount; but, even allowing the average quantity found by Dumas in metal which had been melted in the air under ordinary circumstances, we calculated that this amount would only affect the third decimal place in the atomic weight of antimony; and it seemed therefore unnecessary to take so inappreciable an effect into consideration. Moreover, the great purity of our material was subsequently made evident.

one-tenth of a milligrm. Moreover, it will be noticed that the volumetric method is only used to estimate the difference in the atomic weight which has been in question, and that, if the method were only accurate to the one-tenth of the quantity to be measured, it would give us the value of the atomic weight within two-tenths of a unit, while if, as we had reason to believe, the process was accurate within 1 per cent, it would fix the atomic weight within 2-100ths of a unit.

By the method just described, the following results were obtained. The letters *a* and *b* indicate different preparations:—

	Wt. of $SbBr_3$ taken.	Total Wt. of Ag used.	Per cent of Br. Ag=108 Br=80.	Corresponding value of Sb.
a 1.	2·5032	2·2528	66·6643	120·01
a 2.	2·0567	1·8509	66·6620	120·02
a 3.	2·6512	2·3860	66·6644	120·01
b 4.	3·3053	2·9749	66·6696	119·98
b 5.	2·7495	2·4745	66·6653	120·01
Mean value,			66·6651	120·01
Theory Sb. 120 requires			66·6666	
,, Sb. 122 ,,			66·2983	

The extreme variation from the mean in these determinations is less than one ten-thousandth of the quantity directly estimated, and corresponds to less than two ten-thousandths of the total value in the atomic weight of antimony. We have thus reached the extreme limit of accuracy with determinations on this scale. By using very much larger amounts of material, it is possible that we might still further diminish the limits of experimental error; but when we consider the further causes of error incident to handling so large an amount of material, it seems doubtful whether any advantage would really be gained. At all events such determinations would require an expenditure of labour and skill which is not demanded in the present condition of chemistry.

While making the first three volumetric determinations, it became obvious that the mode of experimenting was highly favourable to the accurate estimation of the amount of bromide of silver formed; and, were we to repeat this investigation we should adopt the same mode of precipitating bromine in all cases. The rotatory motion given to the liquid mass in the stoppered flask in order to hasten the "clearing up," after each fresh addition of the silver solution, tends very greatly to granulate and thoroughly wash the precipitate. In the last two determinations, therefore, we collected and weighed the bromide of silver formed, and this weight gave us a most important control over the whole work. In the previous work we assume that the ratio of Ag : Br = 108 : 80, and find that on this assumption Br : Sb = 80 : 120. But if we both determine the amount of silver required to precipitate a given weight of antimonious bromide, and also at the same time the weight of argentic bromide formed, it is obvious that we fix at once the ratio of three atomic weights (Ag : Br : Sb) independently of any assumption whatsoever. This, so far as we know, is a new feature in investigations of this kind, and evidently vastly diminishes the possibilities of error, and enhances the value of the result. We give in full the two determinaiions which were made in this way:—(See Table, next column).

Bringing, now, these results together, we have two additional gravimetric determinations of the atomic weight of antimony.

	Weight of $SbBr_3$ taken.	Wght. of AgBr determined.	Per cent Bromine Ag=108 Br=80.	Corresponding value of Sb.
b 6.	3·3053	5·1782	66·665	120·01
b 7.	2·7495	4·3076	66·667	120·00
Mean value			66·666	120·00

It is now obvious that these gravimetric determinations, taken in connection with the corresponding volumetric

No. I.

	Grms.
Weight of tube and $SbBr_2$	22·2225
,, after transfer to flask	18·9172
,, of $SbBr_3$ taken	3·3053
,, of silver taken	2·9749
Weight of crucible and filter..	44·3729
,, ,, with AgBr dried at 150° ..	49·5512
,, ,, after again heating	49·5512
,, of AgrBr dried at 150°	5·1783
Weight of crucible and AgBr after removing small filter with adhering particles	49·5008
Weight after heating AgBr to incipient fusion..	49·5007
Reduced weight of AgBr	5·1782
Per cent of bromine	66·665
Atomic weight of antimony	120·01

No. II.

	Grms.
Weight of tube and $SbBr_3$	32·4979
,, after transfer to flask	29·7484
,, of $SbBr_3$ taken	2·7495
,, of silver taken	2·4745
,, of crucible and filter..	44·3732
,, ,, wlth AgBr dried at 150° ..	48·6810
,, ,, after again heating	48·6810
,, of AgBr dried at 150°	4·3078
Weight of crucible and AgBr after removing small filter with adhering particles	48·5524
Weight after heating AgBr to incipient fusion..	48·5522
Reduced weight of AgBr	4·3076
Per cent of bromine	66·667
Atomic weight of antimony	120·00

results, give us the most conclusive evidence of the purity, both of the metallic silver used, and also of the bromine in the bromide of antimony, which is the basis of this atomic weight investigation. By comparing *b* 6 and *b* 7 with *b* 4 and *b* 5 respectively, we obtain the following data:—

Grms.		Grms.	
1. 2·9749	of silver gave	5·1782	bromide of silver.
2. 2·4745	,, ,,	4·3076	,, ,,

Hence it follows that, as shown by these experiments, the proportions of the silver to the bromine were respectively:—

1.	108·00	silver to	79·99	bromine
2.	108·00	,, ,,	80·01	,,
Mean value..	108·00	,, ,,	80·00	,,

This is the ratio of the atomic weight of silver to that of bromine, and corresponds to the second decimal place with the determinations of Stas as well as with those of Dumas.

We have now furnished as evidence of the atomic weight of antimony—

1. The mean of fifteen analyses of bromide of antimony purified by crystallisation from sulphide of carbon, with an extreme variation between 119·4 and 120·4 for all the fifteen analyses.

2. The mean of five analyses of bromide of antimony purified by distillation and sublimation, with an extreme variation between 119·90 and 120·08.

3. The mean of five volumetric analyses of bromide of antimony, also purified by distillation and sublimation, with an extreme variation between 119·98 and 120·02.

4. Two gravimetric determinations of the bromine in two of the portions of bromide of antimony used in the volumetric analyses, but still essentially distinct determinations, which gave almost identical results.

Bringing these several means together as of equal value, we have :—

		P.cnt. of Br.	Value of Sb.
1.	Mean of 15 determinations ..	66·666	120·00
2.	,, 5 ,, ..	66·668	119·99
3.	,, 5 ,, ..	66·665	120·01
4.	,, 2 ,, ..	66·666	120·00
	Final mean value	66·666+	120·00

Furthermore, we have shown by the last two determinations that the ratio of the atomic weight of the silver to that of the bromine used in our experiments was 108·00 to 80·00, and hence that the ratio of the atomic weights of bromine, silver, and antimony must be—

Ag : Br : Sb = 108·00 : 80·00 : 120·00,

with a probable error not exceeding 0·01 in any case. Of course our experiments only serve to fix the ratio between these three quantities, and any considerations which may lead chemists to change the value of one of the quantities must affect the other two in the same proportion. If with Stas we take Ag = 107·66, then Br = 79·75, and Sb = 119·63 ; and in this connection the fact should be recalled that the ratio of Ag to Br, according to Stas, is essentially identical with that given above, and the same as that found both by Dumas and by Marignac. Of all the ratios between the atomic weights, it is the one in regard to which there is the greatest certainty, and it is with this very well-established relation that we have connected the atomic weight of antimony.

Entirely in harmony with the above results are our experiments on the synthesis of sulphide of antimony, in which we found as a mean of thirteen experiments Sb = 119·94 when S = 32 ; and the same is equally true of our analyses of iodide of antimony, which gave as a mean of seven determinations Sb = 119·98 when I = 127·00. But although these results formed important stages in our investigation, they now add but little to the evidence of the far more accordant results since obtained. When compared with these later results they show, however, to what a great extent error may be eliminated by the repetitions of an imperfect process.

Lastly, the anomaly which the analysis of antimonious chloride first presented has been explained by finding, first, that the material employed contained a constant amount of oxychloride ; and, secondly, that the water used in washing the precipitate exerted a definite solvent action on the chloride of silver estimated.

Having thus solved the problem we undertook as far as is at present practicable, we must now take leave of the subject, regretting only that our investigation should have been the occasion of any controversy. In addition to the recognition we made in our previous paper, we would here express our obligations to Mr. G. De N. Hough and Mr. G. M. Hyams, who have greatly aided us in the experimental work during the latter part of this investigation.

(To be continued.)

Action of the Treatment of Cream with Oxygen upon the Quality of Butter.—Prof. L. B. Arnold.—The fatty matter of milk improves in aroma by a short action of the oxygen of pure air. A more prolonged action is hurtful. The butter from milk which has been excluded from oxygen does not keep as well as that from milk which has been exposed to the air.—*Biedermann's Centralblatt.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 12th, 1881.

Professor FULLER, Vice-President, in the Chair.

MR. W. D. NIVEN was elected a Member.

Mr. LEWIS WRIGHT then read a paper "*On some Spirals observed in Crystals, illustrating the relation of their Optic Axes.*" After remarking that the relation of the axes in uni-axial and bi-axial crystals had always been an interesting subject, he observed that if we took any uni-axial and a single axis of any bi-axial which had little or no axial dispersion, and polarised and analysed each circularly, we ultimately got similar phenomena. This is illustrated by calcite and a single axis of sugar, each giving when thus treated unbroken circular rings. From this it might be hastily inferred that a single axis of a bi-axial resembled in character the axis of a uni-axial ; but this was not the view of those who framed the theory of double refraction in crystals. Fresnel finally framed the conception of three elasticities in three rectangular directions. If all were equal there was no double refraction ; if only two were equal there was a single optic axis in the direction of the third ; and if all were unequal there were two optic axes. According to this theory the axis of the calcite did *not* resemble in character a single axis of the sugar or other bi-axial, but was a limiting case in which *both* such axes coincided. This was illustrated by the beautiful experiment of Professor Mitscherlich, applying heat to a crystal of selenite, and thereby altering the respective elasticities. The two axes gradually approached until they coincided and the crystal became uni-axial, after which, on heating the crystal still more, the axes re-opened in a direction at right angles to the former, thus proving Fresnel's theory. It was desirable to illustrate the point—that the axis of a uni-axial did retain, or still embraced within itself in some visible form, characteristics of the two axes thus brought into coincidence. Sir George Airey had discovered the double spiral in quartz. Uni-axial calcite showed a doule spiral, and bi-axial gave a single spiral. Mr. Wright repeated Professor Mitscherlich's experiment, on this additional basis of analysis, the spirals being first shown perpendicularly above each other. Gradually they approached until they resembled those of the calcite, and finally opened out again horizontally. All through there was a double spiral, and a single one could only be got by separating a single axis : the fluid would represent the axial properties of the quartz and the crystal the other properties, and the two ought to give similar spirals. In fact the fluid should replace the quartz successfully in all these experiments. By means of a column of oil of lemons 200 millimetres in length, and crystals of calcite, sugar, topaz, and nitre, Mr. Wright showed this to be the case. Finally, he demonstrated that the same phenomena held good through all the ordinary analogies with, or artificial substitutes for, natural crystals, the figures being produced with a circular chilled glass in parallel light, and also with an artificial uni-axial crystal made of crossed mica films, after Norremberg, and an artificial quartz made of superimposed mica films, after Reusch, in convergent light. All the figures were projected by the electric camera, to a size 8 feet in diameter. All Mr. Wright's experiments went to illustrate the truth of Fresnel's theory.

Mr. C. V. BOYS then read a paper "*On the Prevention of the Bursting of Water-pipes.*" Mr. Powell had proposed the use of pipes of elliptical or other round section, and Mr. Mangnall, of Manchester, had independently hit on the same idea. Such a pipe would become rounder in section when the water froze and expanded. A round pipe tends to become thinner at its weak parts on expanding under the pressure. With an elliptical pipe the force

required to alter the shape of its section is greater as the section is more circular, therefore the effect produced by a change of shape at any place makes that place stronger. A round pipe is in a state of unstable, and an elliptical pipe in a state of stable, equilibrium, and changes its form uniformly from end to end. Hence, if a portion only of such a pipe is exposed in the cold the whole is effective, and it will require a proportionally greater number of frosts to make the pipe round. Inspection would show if the pipes were becoming round, and then they could be squeezed back to their original shape. Mr. Boys had demonstrated these inferences by experiment with Mr. Powell. Messrs. Powell, Rigby, and Co., of Piccadilly, made these pipes.

Mr. J. Macfarlane Gray drew attention to some apparent discrepancies in the constants employed by Regnault in his work on the Physical Properties of Steam.

NOTICES OF BOOKS.

Description of the Chemical Laboratories at the Owens College, Manchester. By H. E. Roscoe, F.R.S. Third Edition. Manchester: J. E. Cornish.

From this summary it appears that there are in the College two large laboratories, each 70 ft. long, 30 broad, and 29 high. One of these is occupied by the first year's or qualitative students, and contains sixty working places. The second laboratory, for the advanced or quantitative students, contains ten blocks, of four working benches each. The ventilation arrangements are two-fold, general and special, both worked by means of the furnace chimney. The general ventilation is so successful that when a hundred students are at work in the two rooms, the air remains pure. The special ventilation relates to the evaporation niches and sulphuretted hydrogen closets. The large niches aspirate 100 cubic feet of air per minute, and the smaller ones 12 cubic feet per minute. The action is so good that no smell nor escape of vapours into the laboratory can take place, even when sulphuric acid is evaporated in quantity. The sulphuretted hydrogen closets vent into a horizontal flue, running underneath the floor, and thence passing into the chimney.

These two large laboratories are on the ground floor, which contains, in addition, a special room for organic analysis, two balance rooms, a room for gas analysis, a library, a lecture theatre for organic chemistry, Professor Schorlemmer's private room, and a store and reagent room. The first floor contains Professor Roscoe's private room, private balance room, and private laboratory.

The basment contains, in addition, a laboratory for medical and evening students, fitted with work-places for fifty; a special metallurgical laboratory provided with furnaces, a store room, class room, lavatory and cloak room, a spectroscopic room, photographic room, a dark room for photometry, three preparation rooms, and a boiler house. There is also a lecture theatre, capable of accommodating 380 persons with a small laboratory for the lecturer's use immediately behind the platform, and a store room for diagrams at the opposite end.

The Owens College, in addition to eminent and zealous professors, now possesses appliances and facilities for research admirably arranged and second to few, if any, in Europe. We may reasonably hope that the results will be in proportion to the opportunities afforded.

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives. London: Macmillan and Co.

With this volume Professors Roscoe and Schorlemmer enter upon the organic portion of their great work in such a manner that this division will equal, if not exceed, the inorganic portion in value. The volume begins very appropriately with a history of organic chemistry from the earliest traditions of antiquity down to the present day. The authors trace the successive rise and fall of theories and the various definitions given of organic compounds, adopting finally the one given on the title-page. They call attention to the fact that Lavoisier did not, as is sometimes asserted, recognise organic chemistry as a special branch of the science or define it as the chemistry of compound radicles. On the contrary, he arranged all acids together, dividing them into the three classes of mineral, vegetable, and animal. Yet on the opposite page we read that—"Agreeing with the views of Lavoisier, Berzelius explained the difference between these two great divisions by stating that whilst in organic nature every oxidised compound contains a *simple radical*, organic bodies consist of oxides of *compound radicals*."

The section on the ultimate analysis of organic bodies is very elaborate. The authors describe and illustrate the determination of hydrogen and carbon by the methods of Lavoiser, Berthollet, Gay-Lussac, Berzelius, and Liebig with its modifications; the determination of nitrogen according to Will and Varrentrapp; the "relative" methods of Liebig and of Bunsen; the absolute method of Dumas and of Simpson. Processes for the determination of other elements are then described, as well as processes for ascertaining vapour-densities, including that used by Victor Meyer in his recent investigations. After explaining the determination of molecular formulæ, the authors pass to the main or descriptive portion of their work, beginning with the hydrocarbons of the paraffin series; the compounds of the monad alcohol radicles; the alcohols and their derivatives; synthesis of the primary alcohols and the fatty acids; the secondary and tertiary alcohols; the methyl, formyl, and ethyl groups, and compounds containing higher numbers of carbon atoms from three to twenty-four.

As in the organic portion of the work, the illustrations, both of laboratory apparatus and of plant or appliances on a larger scale are numerous, admirably executed, and well selected. Footnotes in abundance refer the reader to the original memoirs, &c., for fuller information, so that the work in some measure serves as a general key to the literature of organic chemistry. The index is admirable, extending over twenty-five pages, and being at once full and accurate. Thr whole work, if completed on its present scale, will, as a systematic treatise on modern chemistry, have no superior in any language.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 16, October 17, 1881.

An Experimental Peculiarity Relative to the Equipotential Law followed by Nobili's Rings.—Ad. Guébhard.—The author refers to the fact that on placing above a metallic plate, forming the bottom of an electrolytic vessel, points of any number attached to the conductors of a battery of strong tension, the coloured rings which take their rise always correspond in a striking manner to the equipotential systems which take their rise on applying directly, upon an isolated plate, poles of signs contrary to the former. Hence a natural assimilation of the phenomenon of dynamic efflux to a simple phenomenon of static induction, and the necessity, theoretically, of considering the liquid as an almost absolute insulator, in which the passage or efflux of the elec-

tricity can take place only by following the minimum traject from the point to the plate. This latter fact, little in accord with the original figures of Nobili and with current ideas concerning electrolysis, has been verified experimentally by the author, who has studied, under strongly concentrated illumination, the liquid currents from one electrode to the other, rendered visible either by the transportation of material particles, or by the disengagements of gases which accompany them. These latter are produced in great abundance in the double tartrate of antimonyl and potassium, between the positive plate and the negative electrode. Myriads of microscopic bubbles move in dense files along the plate till in close vicinity to the electrode, and then rise suddenly with an abrupt curve, following its surface to the upper surface of the liquid. What can these trajectories be but lines of force of the electric efflux? Kirchhoff has shown long ago that the quantity of electricity which traverses each element of a conductor of finite dimensions must be proportional to the potential and not to the elementary density of the electricity. A direct application of the law of Faraday leads, then, to the law just pointed out.

Crystalline Copper Sulphide (Cupreine) formed from Antique Medals at the Thermal Springs of Flines-les-Roches, Department of the North.—M. Daubrée.—The water in question forms a pool of about 300 metres in diameter. In ancient times this water was an object of worship, and numerous bronze coins and statuettes, both Gaulish and Roman, appear to have been thrown into it as offerings. Upon these there has been formed by the action of the water, an incrustation of that kind of chalcosine described by Breithaupt as cupreine. The water contains neither free sulphur nor sulphides, but merely sulphates, which are reduced by the organic matter.

Currents produced by Atmospheric Electricity, and the Telluric Currents.—J. Landerer.—The author observed since June, 1876, the currents produced in a telegraphic wire stretched between two houses to the length of 288 metres. Some of these currents are produced by the condensation of watery vapour. They may be recognised by means of a telephone, but scarcely, or not at all, by a sensitive galvanometer. The sound they produce in the telephone is like the creaking of tin. Other currents are produced by the discharge, more or less remote, of the electricity of the clouds; the sound is a continued crackling. On the approach of tempests the sound resembles that produced by a jet of steam. So called sheet lightning produces a very distinct effect. These currents have a well-marked action upon the galvanometer. There are, lastly, currents produced by the wind; they are without action upon the telephone, but they act strongly upon the galvanometer. Their intensity is a function of the strength of the wind. There are intervals of repose in which none of these currents are manifested. Telluric currents act both upon the galvanometer and the telephone. They are distinguished from atmospheric currents by the regularity and continuity of their action, during long intervals.

Action of Sulphur upon Alkaline Sulphides in very Dilute Solutions.—M. Filhol.—Sulphur acting upon sodium mono-sulphide, even in very dilute solutions, gives rise to the formation of a poly-sulphide, without the production of a notable quantity of poly-sulphide. It is, however, more rational to admit that the mono-sulphide, which was decomposed under the influence of water into hydrosulphate and hydrate, is reconstituted in presence of sulphur, and gives rise to the production of a poly-sulphide.

A New Base of the Cinchonaceæ.—M. Arnaud.—The base in question, which the author names cinchonamine, differs from hydro-cinchonine, both chemically and physically. It is represented by the formula $C_{19}H_{24}N_2O$.

A New Series of Bases derived from Morphine.—E. Grimaux.—There is a general reaction which renders it possible to obtain the homologues of codeine, containing new alcoholic groups, not in the phenolic oxyhydrile of morphia, but in the hydrocarbonated radical of the morphia itself. Metho-codeine is thus an isomer of codethyline.

Dissociation of Ammonium Carbamate.—R. Engel and R. Moitessier.—The authors have shown that chloral hydrate, butyl-chloral hydrate, and chloral alcoholate, do not exist in the state of vapour, their supposed vapour being merely a mixture of the vapours of their components. They have now subjected ammonium carbamate to an examination from the same point of view.

Justus Liebig's Annalen der Chemie,
Band 208, Hefts 1 and 2.

Benzarsenic Acids and their Derivatives.—W. La Coste.—We have here an account of benzarsenic acid, para-benzarsenic acid, arseno-benzoic acid, the potassium calcium, silver benzarsenates, benzarsenic methyl-ether, benzarsen-iodide, benzarsenious acid and its calcium and silver salts, benzarsenious chloride, dibenzarsenic acid and its derivatives, para-ditolyl-arsenious chloride, para-tolyl-arsenoxide, para-ditolyl-arsenic acid, silver ditolyl-arsenate, para-dibenzarsenic acid, methyl-dibenzarsenate, dibenzarseniodide, dibenzarsenious acid and its calcium salt, tribenzarsenic acid, tri-tolyl-arsen-dichloride, potassium and calcium tri-benzarsenates, tri-benzarsenious acid with its sodium and silver salts. The author's experiments on the oxidation of dimethyl-arsenic and ethyl-arsenic acid were only partially successful.

Researches on the Non-Saturated Acids (Fifth Part).—Rudolph Fittig.—These researches comprise a memoir on pyroterebic acid, by Carl Geisler; further communications on the lacton of isocapronic acid, by Jul. Bredt; on the lacton of normal capronic acid, by R. Fittig and E. Hjelt; on the terpenylic and teracrylic acids, and on hepto-lacton, by R. Fittig and O. Krafft; on allyl-acetic acid and valero-lacton, by A. Messerschmidt; on a simple preparation of and on the constitution of valero-lacton, by L. Wolff; on the constitution of the lactons, and on their formation from the addition-products of the non-saturated acids, by R. Fittig.

The Condensations of the Pyruvic Acids.—C. Böttinger.—The author examines the behaviour of pyruvic acid when heated with water and a quantity of barium hydrate sufficient to neutralise the acid; its behaviour when boiled with water and an excess of the hydrate; and lastly, its behaviour on treatment with ammonia.

Sodium Hyposulphite (Hydrosulphite of Schützenberger).—Aug. Bernthsen.—The author contests experimentally the formula proposed by Schützenberger, and assigns to it the composition $NaSO_2$.

Separation and Determination of Arsenic.—Emil Fischer.—The separation of arsenic from a given mixture with other metals by distillation with ferrous chloride, and its subsequent determination with solution of iodine, offers so great advantages that scarcely any of the older methods will be used when the determination of this element alone is required. If the substance in question is already dissolved, the whole operation may be completed in four hours. The process is especially adapted for chemico-legal cases.

Alkaloids of Belladonna Root and of Datura Seed.—Ernst Schmidt.—An account of very elaborate researches on atropine, daturine, and hyoscyamine.

Certain Derivatives of Phthalic Acid.—O. Miller.—Not susceptible of useful abstraction.

Band 208, Heft 3.

Communications from the University Laboratory of Halle.—These consist of a memoir on methyl-crotonic acid and angelicic acid, and a paper on the double calcium salt of methyl-crotonic acid and of isobutyl-formic acid,

both by Ernst Schmidt; and on a paper on the substituted glycolic acids, by Dr. M. Senff.

Anhydro-Compounds.—H. Hübner.—This is the first portion of a treatise extending over more than fifty pages, and incapable of useful abstraction.

Communications from the Chemical Laboratory of the University of Moscow.—These communications comprise a memoir on tetrylen-dicarbonic acid (homoitaconic acid), by W. Markownikoff and A. Krestownikoff; and an account of dichlor-hydrine and its oxidation-products, by W. Markownikoff.

Lycopodine, the First Alkaloid of the Vascular Cryptogams.—Karl Bœdeker.—The alkaloid in question is obtained from *Lycopodium complanatum*, known as being richer in alumina than any other plant. Its composition is expressed by the formula $C_{32}H_{52}N_2O_3$. It melts at 114° to 115°, dissolves easily in alcohol, chloroform, benzol, amylic alcohol, ether, and water. Its taste is bitter. The very dilute aqueous solution is rendered turbid, and coloured brownish red by iodine water.

Gazzetta Chimica Italiana.
Anno 10, Fasc. 5 and 6.

Hippurates of Isobutyl and Normal Butyl.—G. Campani and D. Bizzarri.—The hippurate of isobutyl forms minute prismatic crystals with a rhombic base, transparent, iridescent when examined by polarised light, of a bitter persistent flavour, insoluble in water, soluble in alcohol, ether, benzol, and chloroform, from which liquids it is easily deposited on evaporation in prismatic crystals. It melts between 45° and 46° to a perfectly homogeneous liquid. The hippurate of normal butyl crystallises much less readily than its isomer. It melts between 40° and 41°.

Composition of the Ash of the Stem, Leaves, and Fruit of the Orange, the Mandarin Orange (Citrus Deliciosa), and Citrus Bigaradia. — Dr. Leonardo Ricciardi.—Not capable of useful abstraction.

A New Cumo-phenol.—M. Fileti.—In this preliminary communication the author states that he has obtained the new compound by the action of nitrous acid upon the cumidine obtained from amido-cuminic acid.

Preparation of Camphoric Acid and of Camphoric Anhydride.—Pietro Maissen.—The author takes as his raw material, residues from the preparation of borneol by Baubigny's method, consisting of a mixture of borneol and of unaltered camphor.

Galvanic Polarisation produced by Metallic Deposits.—Prof. D. Macaluso.—This paper does not admit of useful abridgment.

Bulletin de la Société Chimique de Paris,
Tome 36, No. 3.

Alcoholate of Chloral.—M. Berthelot.—The author has undertaken the thermic study of this compound, and especially the measurement of the heat liberated by the union of alcohol and chloral, giving rise to this compound in the solid, liquid, and gaseous states.

The Evaporation of Glycerin.—G. Couttolenc.—Aqueous glycerin loses its water, after having been heated for five hours in the water-bath to about 90°. The evaporation of the glycerin then continues very regularly at the rate of about 0·00317 grm. per hour and per square centimetre of surface.

Acrolein Bromide (Aldehyd Dibromo-propionic). MM. Grimaux and Adam.—Not suitable for useful abstraction.

Determination of the Dry Extract Left in Wine.—L. de Saint-Martin.—M. Gautier has recently proposed a new method, which consists in evaporating 5 c.c. of the wine in question *in vacuo*, at first over sulphuric acid, and ultimately over phosphoric anhydride. The author, having compared this process with the old method, concludes that the inaccuracy of the latter has been much exaggerated, and that under certain conditions it gives good results. The process of evaporation *in vacuo* is also not free from objections. He proposes to determine the dry extract of wine by evaporating it in a current of highly rarefied dry air at a temperature not exceeding 50°. He finds this method very useful for determining the solid matter in samples of milk, urine, &c.

Formation of a Carbo-glucosic Acid. —P. Schützenberger.—The author heats to 100° for some hours a solution of inverted sugar along with hydrocyanic acid in a closed vessel. The liquid is decolourised by filtration over animal charcoal, and after expulsion of the excess of hydrocyanic acid, it is found to have lost its rotatory power and all action upon cupro-potassic liquid. It contains the ammoniacal salt of a carbo-glucosic acid, $C_7H_{13}O_8$.

Russian Chemical Society.— Session of Jan. 8/20, 1881.—M. A. Krakan.

M. Gustavson described the hydrocarbons yielded at common temperatures by the petroleum of America and of the Caucasus under the influence of aluminium bromide.

MM. Beilstein and Kourbatoff observe that the hydrocarbons C_n H_{2n}, contained in Caucasian petroleum, do not resist the action of nitric acid, bromine, and sulphuric acid. The saturated hydrocarbons of American petroleum are slowly oxidised by nitric acid.

M. Schirokoff gave a description of the characteristic properties of diethyl- and dipropyl-lactic acids and of their salts.

M. Saytzeff gave the result of new researches on the calcium and barium salts of the diethyl- and methyl-propyl-lactic acids.

M. Przybytek, on studying the oxidation of glycerin by nitric acid, has not hitherto observed the formation of any body belonging to the glucose series, which, however, he considers as probable.

M. Louguinine described his researches on the combination-heats of some bodies of the fatty series.

Moniteur Scientifique, Quesneville.
August, 1881.

Anthracic Vaccination.—The recent successful experiments of M. Pasteur and his principle of the attenuation of the contagious virus were the subject of a warm debate at the session of the Academy of Medicine, on June 24th.

The Ptomaines.—P. Brouardel and E. Bouty.—The ptomaines may be distinguished from the natural alkaloids by their power of instantly reducing potassium ferricyanide and silver bromide. It appears that in certain diseases, especially of the septic class, alkaloids resembling the ptomaines may be produced during life.

Colouring-matters.—Dr. W. Weyl.—A list of German patents relating to colouring-matters.

MEETINGS FOR THE WEEK.

MONDAY, Nov. 21st.—Medical, 8.30.
TUESDAY, 22nd.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 23rd.—Society of Arts, 8.
THURSDAY, 24th.—Royal, 4.30.
—— Philosophical Club, 6.30.
FRIDAY, 25th.—Quekett Microscopical Club.
SATURDAY, 26th.—Physical, 3.

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THE CHEMICAL NEWS.

Vol. XLIV. No. 1148.

ON THE ACTION OF THE OXIDES OF NITROGEN ON GLASS AT A HIGH TEMPERATURE.

By THOS. M. MORGAN.

Several attempts were made to determine the nitrogen in organic nitro-derivatives by heating the substance in sealed tubes of hard glass containing oxygen, and in presence also of a little mercury to effect the reduction of any oxides of nitrogen which might be formed, but in all cases the nitrogen obtained was considerably less than the quantity theoretically present in the substance analysed. The source of this deficiency was eventually traced to the action which the oxides of nitrogen exerted on the alkali of the glass, and also on the mercury. For when some of the tubes which had been subjected to a temperature not above dull redness were washed with a little water, the washings could always be shown to contain a nitrate and a soluble salt of mercury; others, the temperature of which had been higher, contained nitrates and nitrites, but no soluble mercury salt.

For the purpose of showing more conclusively that the glass was thus attacked, and in order also to investigate the extent of the action, the following experiment was performed. A tube of hard glass, 50 c.c. capacity, was cleaned until the evaporated washings left no appreciable residue. A quantity of oxygen was next introduced, and then so much nitric oxide that the tube was filled with red fumes; after which it was heated to dull redness for two hours. When cold it was still full of red fumes, and when these were withdrawn it was washed as before, and the evaporated washings left a residue of 0·0038 of a grm., consisting of nitrates and nitrites. The same experiment was repeated three times on the same tube, the second residue was 0·0044 of a grm., and the third 0·0022. Another tube gave 0·0048.

As might be expected, this action is much more energetic at a high than at a low temperature, and it appears to be very slight until the heat approaches redness. In the analysis of such nitrogenous compounds as have the nitrogen in combination with oxygen, a certain deficiency of nitrogen, varying with the temperature employed, may therefore be expected.

Victoria College, Jersey.

NOTE ON THE REVERSAL OF THE SPECTRUM OF CYANOGEN.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

In the course of many observations on the reversal of lines of metallic spectra, we have frequently noticed dark shaded bands which appeared to be the reversals of bands ascribed to the oxides or chlorides of sundry metals; more particularly we have seen them when experimenting with compounds of the alkaline earths, and we have repeatedly obtained a reversal of the green magnesium-hydrogen series; but, until recently, we have never seen any reversal of the shaded bands of the spectrum of cyanogen, though our attention has been constantly directed to this spectrum. Quite lately, however, we have obtained photographs which show the reversal of the violet and ultra-violet bands of this spectrum; and the fact is perhaps of sufficient interest, especially in connexion with the question of the occurrence of these bands amongst the Fraunhofer lines, to warrant the publication of this note. We have not yet succeeded in determining precisely the conditions under which the reversal can be produced at will. The most complete reversals of these bands were obtained by the use of the arc of a Siemens' machine, in a crucible of magnesia, fed with a considerable quantity of cyanide of titanium. The photographs in this case show a very complete reversal of the five bands near L, and of the two strong bands near N, and a less complete reversal of the six bands, beginning at about wave-length 4215. No other metallic cyanides have given, when introduced into the crucible, any such reversal; nor does a stream of cyanogen, led in through a perforated carbon, produce the effect. Various other nitrogenous compounds have been tried, but the only one which has given us anything like the effect of the titanic cyanide is borate of ammonia. Some photographs taken immediately after the introduction of borate of ammonia show distinctly the reversal of the group of bands near L. In one case when metallic magnesium had been put into the crucible, the photograph shows a reversal of only that part of the series which is nearest to the magnesium group, indicating that the reversal is due to the bright background supplied by the expanded magnesium lines. There can be little doubt that the greater stability of titanic cyanide and boron nitride than of other nitrogenous compounds, has some influence upon the result; and the difficulty in producing the reversal at will is in securing an absorbent stratum of sufficiently high temperature and at the same time a sufficiently luminous background. The circumstances which secure the former condition almost always produce in the arc a still more intense radiation of just those rays which are absorbed, without that expansion of the lines which shows out the absorption in the case of so many metallic spectra. The photographs are, however, conclusive evidence that it is possible to secure both conditions.

* Read before the Royal Society, November 17, 1881.

ON MANGANESE NODULES AND THEIR OCCURRENCE ON THE SEA-BOTTOM.*

By J. Y. BUCHANAN.

The specimens exhibited consist of two nodules from the South Pacific and of several from Loch Fyne in Scotland, a number of manganiferous worm tubes, and two samples of the mud in which these tubes and nodules are found in Loch Fyne. I have, besides, some very curious specimens of cobalt nodules from New Caledonia, which I owe to the kindness of my friend Prof. Liversidge, of the University of Sydney. These have recently come into my hands only within the last few days, and I exhibit them as curiosities which may have an interest for some of the members present.

My method of dredging for mud consists in anchoring the vessel by a dredge in the form of a Trotman's anchor, which carries a frame instead of a bar, connecting the flukes. To this frame is laced a bag, which receives the mud which would otherwise drop off the anchor on heaving up. This method has proved successful in two ways. First, by keeping the vessel stationary, while the anchor is down, and so admitting of temperature observations being made, and water samples being collected without having to resort to troublesome manœuvres, and second, by bringing up a large specimen of the mud taken, not from the soft surface layer, as is the case with the flat dredge, but from the underlying and stiffer material.

My first and best haul of manganese nodules, however, was brought up on an ordinary kedge anchor and adhering

* Read before the British Association, York Meeting, Section B.

to its flukes. A portion of this mud is exhibited. It is from the deepest part of Loch Fyne, between Tarbert and Skate Island. It was described in *Nature* of Oct. 10, 1878. I have never succeeded in getting mud so rich in nodules again. Part of it when sifted was found to consist of 30 per cent manganese nodules, 7·5 per cent shells, and 62·5 per cent of sandy clay. I doubt very much if even the richest bottom in the Pacific contains a like proportion. The other two samples of nodule bearing mud are from as nearly as possible the same locality, but, though they contain plenty of nodules, these nodules are of a smaller average size, and are present in much smaller proportion to the rest of the mud. Of the nodules collected on the first occasion in 1878, the average weight was 1·7 grms.; of those collected last July, the average weight, after eliminating all that passed through a sieve of four meshes to the inch, was only 0·42 grm., and the proportion of nodules to mud would certainly not be more than 5 per cent. The whole of the mud which came up on this occasion was sifted, with the exception of a small sample, dried as it was; the nodules were then sorted by sieves of different degrees of fineness. The bulk of them were retained by a ¼-inch mesh. The nodules so retained weighed 307 grms., and numbered 726, and it is remarkable that besides these nodules there was nothing on the sieve but a few fragments of shell and *two pebbles*. This affords very strong evidence that the nodules are formed *in situ*, and cannot have been washed into their present position, as in that case they would certainly have been accompanied by pebbles.

Hitherto the deep portion of Loch Fyne above alluded to is the only locality in Scottish waters where I have found the oxide of manganese occurring as nodules. It is, however, widely distributed as incrusting shell and as worm tubes, notably in the channel between Garvelloch Island and the Island of Scarba, and in Loch Sumart. Similarly, during the cruise of the *Challenger*, besides the many localities where the nodules abounded, it was constantly found encrusting shells in calcareous bottoms which were devoid of nodules.

The Loch Fyne nodules resemble the oceanic ones in nearly every particular. They are comparatively soft when first brought up, and become harder when exposed to the air. Heated in the closed tube they give off water charged with ammonia and empyreumatic products. When treated with hydrochloric acid the soluble constituents are removed, and what remains behind includes the insoluble constituents of the surrounding mud. Many of the Loch Fyne nodules have soft kernels, which are richer in oxide of manganese than the rinds.

A considerable number of determinations have been made both of the available oxygen and of the manganese, and if the manganese found be united to the whole of the available oxygen the resulting formula varies between $MnO_{1·5}$ and $MnO_{1·6}$. Taking the soft kernel alone and separated from the sandy rind, the formula is $MnO_{1·75}$. The rind alone had the formula $MnO_{1·5}$. In some oceanic nodules which were examined the formula varied from $MnO_{1·90}$ to $MnO_{1·95}$.

Some of the mud which contained the Loch Fyne nodules was examined. It contained 0·71 per cent of MnO and a hardly-distinguishable trace of extra oxygen.

If we express the available oxygen in terms of its equivalent MnO_2, we have in oceanic nodules from 22 to 32 per cent, in Loch Fyne ones from 13 to 22, and in the kernel treated separately 33 per cent of MnO_2.

The insoluble residue varies in oceanic nodules from 16 to 30 per cent, and in the Loch Fyne ones from 28 to 33 per cent, both containing from 83 to 88 per cent of silica.

Oceanic nodules appear to contain more nickel and cobalt than the Loch Fyne ones, while the latter contain distinct traces of copper, which does not appear to be so common in the oceanic ones.

With regard to the method of formation of these nodules, and the deposition of higher oxides, not only of manganese, but of iron, on the sea-bottom, it is perhaps unwise at the present moment to speak positively, but I think there is enough known to enable us to indicate a probable process of production.

All the nodules without exception contain residues of organic matter; where the oxide of manganese is not aggregated into nodules it is found encrusting animal remains, as shells, worm-tubes, &c. Whether in the form of nodules or incrustations the black matter contains all the recognisable sand and other matter of the surrounding mud; moreover they are certainly formed *in situ*, and not brought from a distance. The mud in Loch Fyne at any rate contains manganese in the form of protoxide, and no doubt as silicates; it also contains oxides of iron, which are present in all manganese nodules and incrustations: indeed in the same dredgeful we can pick out all gradations of nodules from these which contain almost exclusively MnO_2 with only traces of Fe_2O_3 to those which contain Fe_2O_3 without any MnO_2.

The formation of the sesquioxide of iron nodules has gone on under my own eyes. In July, 1879, I dredged from the bottom of the Sound of Jura, in 70 to 80 fathoms, a large mass of very stiff blue clay, as stiff as the best brick-making clay. Throughout the mass there were disseminated patches and pockets of blackish blue matter, which proved to be sulphide of iron, hydrochloric acid liberating sulphuretted hydrogen in abundance. This was dried in the usual way in plates on the cylinder covers of the engine, and when dry not a trace of sulphide was to be found, every black patch being now represented by a reddish brown one, even in the centre of large and compact masses. Now, what has here taken place in a very short time under the combined action of air, moisture, and heat takes place as surely, but more slowly, in the surface layer of the mud at the bottom; and in point of fact, not only in our shallow seas, but even in the deepest water of the ocean, we find the surface layer of the mud almost invariably of a different colour from the underlying mass, the top being red, while below the mud is grey. I believe, then, that for the formation of the nodules we have to look to the organic world as a necessary, though indirect, assistant. The decomposition of animal matter in presence of the sulphates of the sea-water reduce these to sulphides, which in their turn react on the iron and manganese minerals (principally silicates) in the mud forming sulphides of these metals. As the organic matter gets exhausted these sulphides are oxidised to oxides by the oxygen of the water, forming concretions or incrustations of the ochreous oxides, which naturally also enclose the other and unaltered constituents of the mud.

In conclusion, I cannot help thinking that the shell-producing animals of the sea obtain the lime from the sea-water in this way, the lime being assimilated from the dissolved sulphates in the form of sulphide in the interior of the animal, and transformed into carbonate on the outside.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING OCTOBER 31ST, 1881.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

November 5th, 1881.

SIR,—We lay before you, in the following tables, the results of our analyses of the 182 samples of water, collected by us during the month of October, on the days

and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, three were noted as "very slightly turbid." The remaining 179 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from October 1st to October 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright,

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole, excepting two which were recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole, excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

As regards general appearance, the waters during the past month were clear, and afforded evidence of efficient filtration. Chemically, they were pure, and showed a freedom from all matters, mineral or organic, in any degree harmful. Dietetically they were of good quality, and perfectly wholesome for use as drinking waters.

We have the honour to remain, Sir,

Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.*

By JOSIAH PARSONS COOKE, Director.

(Continued from p. 248.)

V. The Boiling Point of Iodide of Antimony, and a New Form of Air Thermometer.

In continuation of our investigations on the Haloid Compounds of Antimony, the boiling-point of antimonious iodide has been determined by Mr. W. Z. Bennett, at the time a student in this laboratory. The observations were made with Regnault's air thermometer, but it was found possible to simplify very greatly the details of the process without seriously impairing the accuracy of the result. For temperatures above the range of a mercury thermometer's measurements, accurate to one degree centigrade, are all that the uncertain conditions of most problems permit, and all, therefore, that the circumstances demand. As used by Regnault, the air thermometer is capable of measuring such temperatures accurately to the one-tenth of a degree, and by multiplying observations possibly to the one-hundredth of a degree. In his admirable investigation of the boiling-point of sulphur at different temperatures, the observations of temperature are undoubtedly accurate to this extent; but Regnault's own discussion of these observations plainly indicates that there must have been unknown or accidental causes influencing his experiments, which render the results uncertain to at least one degree; and the boiling-point of sulphur is still in doubt to this extent. It should be added, however that there are only a very few boiling-points which are known more accurately; for, even when within the range of a mercury thermometer, an observation of a boiling-point, to be accurate to a tenth of a centigrade degree, requires an attention to circumstances which is seldom bestowed on such observations.

The glass thermometer-bulb used in our experiments is represented in the accompanying figure (Fig. 1) of one-half the actual size in its linear dimensions. The longer stem was made of thermometer tube, and a shorter stem was added to the opposite end of the bulb in order to facilitate the cleaning, drying, filling, or emptying of the interior, all of which was easily accomplished by the aid of a Bunsen pump. The shorter stem was of course sealed after the bulb had been dried and made ready for use, and before it was immersed in the medium whose temperature was to be measured. After an equilibrium had been established at this unknown temperature, T'°, the protruding end of the longer stem was sealed, and at the same time the height of the barometer, H, was noted. The bulb was then taken to a room of uniform temperature provided in the laboratory for gas analysis, and, after being mounted on a convenient support, the end of the stem was broken off under mercury, and the apparatus left to itself for a time to secure a perfect equilibrium of temperature. This temperature, T°, was then observed, by means of a standard thermometer hanging near the bulb; also the height, h, to which the mercury had risen in the bulb, was measured by a cathetometer; and in addition the height, H', of a barometer (hanging in the same room) was noted. Closing now the open stem with the finger, the bulb was quickly inverted and the containing mercury drawn out into a tarred vessel and weighed (nipping off the extreme end of the shorter stem for the purpose). This gave the weight, w. Lastly, the bulb and stem having been completely filled with mercury by suction, the weight W, corresponding to their total capacity was obtained in a similar way. The required temperature could now be calculated by means of the well known law of Charles:—

$$T'^{\circ}+273{\cdot}2^{\circ}=(T^{\circ}+273{\cdot}2^{\circ})\,\frac{W}{W-w}\cdot\frac{H}{H'-h}\,[1+(T^{\circ}-T'^{\circ})k]$$

It will be noted that as the mercury columns, including the heights of the barometer, were all measured at the same constant temperature; and, as we are dealing with relative values only, no reductions are necessary. Moreover, an error of one-tenth of a millimetre in the value of—

$$\frac{H}{H'-h}$$

would make, in determining the boiling-point of sulphur (448°), a difference of only one eighth of a degree, so that measurements of these heights are sufficiently close, if accurate, to one-half a millimetre, and might even be made with a common rule. The most uncertain element in the formula is the expansion of glass; but if the bulbs are made of flint glass (lead glass) tubing, such as is used in this neighbourhood for ornamental ware, the mean coefficient of expansion will vary very little from 0·000025, if the temperature does not exceed that at which the glass begins to soften. The rate of expansion of flint glass is not only less than that of crown, but it is also more constant, and increases very slowly with the temperature. Flint

* Presented to the American Academy of Arts and Sciences, May 11

glass is therefore better adapted for the use we are describing. The expansion of the glass used in our experiments was carefully determined, and found to have the value given above, within two or three tenths of a unit in the last place. A difference of one unit in this place would make a difference of one-third of a degree in the boiling-point of sulphur.

In order to test the accuracy of this method, Mr. Bennett made four determinations of the boiling-point of sulphur under different barometric conditions, which in the following table are compared with the results of Regnault, reduced to the corresponding pressures:—

Barometer. Height at 0°.	Boiling-point of Sulphur. Bennett.	Regnault.	Diff.
758·8	447·4	447·3	+0·1
763·9	448·2	447·7	+0·5
769·6	448·2	448·1	+0·1
776·7	448·2	448·7	−0·5

Regnault made eight observations on the maximum tension of sulphur vapour at temperatures varying from 387·64° to 554·03°, and from a discussion of these deduced the constants of an exponential formula, by which he calculated a table of maximum tensions for every ten degrees between the extreme limits, and also plotted a corresponding curve. It so happens, however, that the only two observations within the range of ordinary atmospheric pressure fall outside, and on the same side, of this assumed curve. These observations are the ones usually taken as indicating the boiling-point of sulphur; and Victor Meyer, in one of his methods of determining the density of the vapours of substances which have a high boiling-point, assumes a value for the boiling-point of sulphur (at the mean atmospheric pressure at Zurich), which he obtains by simple interpolation from the two observations just referred to.* In like manner we have calculated the above values corresponding to the pressures at which Mr. Bennett's results were obtained on the basis of the same two obervations; but, instead of simply interpolating by the first differences, we have assumed that the variation between the two observed values would follow the law indicated by the general curve, which Regnault gives as the best expression for all his observations. But according as we take the two observations, or the whole, we obtain values for the boiling-point of sulphur differing by more than a degree; and hence, as we have already said, there is still an uncertainty in regard to the boiling-point to this extent. As is evident, Mr. Bennett's observations confirm very closely the interpretation of Regnault's results, adopted by both Victor Meyer and by ourselves.

After the accuracy of our method had been thus placed beyond doubt within the limits required, Mr. Bennett made three determinations of the boiling-point of antimonious iodide, with the following results:—

Barometer. Height at 0°.	Boiling-point of SbT_3.
758·1 millimetres	400·4°
758·4 ,,	400·9
759·3 ,,	400·9

Probably only a small part of the difference between these observations depends on the variations of pressure. We only regard the method as accurate to whole degrees, and 401° is evidently the boiling-point of antimonious iodide at the normal pressure of the air within half a degree on either side.

The method we have here described we can most confidently recommend as a most efficient and accurate means of determining high temperatures in chemical laboratories. It requires no expensive apparatus, and no more delicate manipulation than most processes of gas analysis. Indeed, this method is most readily associated with Bunsen's method of gas analysis; and, in a laboratory provided with a room fitted for that work, the observation of temperature we have described can be made in a very short time.

In connection with these experiments we were led to devise a very simple and inexpensive form of differential air thermometer, that can be used almost as readily as a mercury thermometer, and which will measure either high or low temperatures with all the accuracy that is usually required. The instrument is represented by Fig. 2 of one-

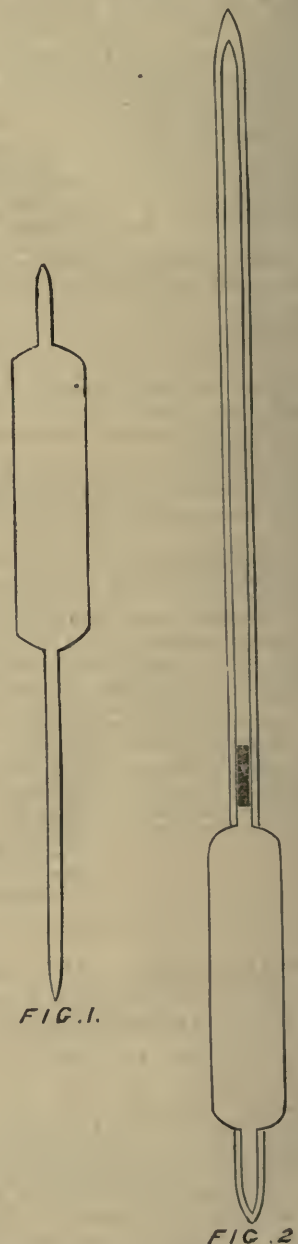

FIG. 1.

FIG. 2

half its linear dimensions. The long stem is made of "barometer tubing," a little over a millimetre in diameter, and by careful calibration is arbitrarily divided into parts of equal capacity, making, we will say, two hundred divisions on the length of the stem. While the instrument is still open at both ends it is easy to determine, first, the weight of mercury which fills the bulb up to the first divi-

* Fresenius's *Zeitschrift*, xvi., 482.

sion of the stem; and, secondly, the weight of a column of mercury covering an observed number of divisions of the stem. These constants being known, and the interior of the instrument having been most carefully dried, for which the two openings offer great facilities, a short column of very pure mercury is introduced, and brought into the position represented in the figure. The two ends are now hermetically closed with a blowpipe, and the instrument is made. It can be used either in a vertical or horizontal position, although the zero point of the scale is slightly different in the two cases, owing to the weight of the short mercury column. Of course this column remains immovable so long as the temperature of the two ends remains the same; but when the bulb is heated, the column, which we will call the index, moves up the stem, which becomes a closed monometer. If the instrument is to be used for measuring low temperatures, the index should be placed about one-third way up the stem before closing the open ends. The theory of the instrument is the same in either case, but in our description we will assume that the index has been set for high temperatures, as shown in our figure.

As the instrument is a differential thermometer, its accuracy depends on keeping the steam at a *constant* and *known* temperature; and from this constant temperature the observed temperatures are deduced. When the thermometer is held in a horizontal position, and the stem can be protected from the neighbouring sources of heat, it is sufficient to place a standard mercury thermometer at the side of the stem; but it is always better, and generally necessary, when the stem is in a vertical position over the source of heat, to surround the stem with a jacket, through which circulates a stream of water of known temperature. This temperature we will call the temperature of reference, and represent by T°. In order now to determine the value in Centigrade degrees of the division of the instrument, we place it in the position in which we propose to use it, and when the two ends are at the same temperature we observe the position of the two ends of the index on the graduate scale. We can now easily find from the weights obtained before closing the instrument, first the weight of mercury which would fill the bulb and stem up to the index, which we call W; and, secondly, the small weight of mercury which would fill one division of the stem, which we will call w. We have also, by observation, the number of division on the stem above the index. This number, which we count from the closed end of the stem, we will represent by N.

Assume, now, that the bulb and stem up to the index is immersed in a medium which has the temperature, T'. The index moves, and in its new position let N' represent the number of division on the stem above the index. We can now easily deduce the following values:—

$\frac{N}{N'}$ = the ratio of the tension of the confined air at T'° and T°.

N − N' = the number of division through which the index moved.

$$\frac{W+(N-N')w}{W} =$$

the ratio of the volumes of the air in the bulb at T° and T'°, independent of the expansion of the glass.

$$\frac{W+(N-N')w}{W}(1+[T-T']k) =$$

same ratio, allowing for expansion of glass.

Then, as we can easily deduce from the laws of Mariotte and Charles:—

$$T'^{c}+273=\frac{N}{N'}(T^{\circ}+273)\frac{W+(N-N')w}{W}(1+[T^{\circ}-T'^{\circ}]k)$$

With this formula it is now easy to compute the values for each division of our arbitrary scale. We cannot, however, depend absolutely on the result, as there are several causes which will differ with each instrument, and of which we can take no account. It is therefore best to observe, with the instrument, two or three well-established boiling-points, which will give us fixed points by which we can correct the table, and we shall then have an instrument whose precision is fully equal to that of a mercury thermometer.

It is, of course, very desirable that the temperature of reference T° should be always the same and as invariable as possible. This is best accomplished, as above suggested, by maintaining a circulation of water through a glass jacket surrounding the stem of the instrument and enclosing also a small mercury thermometer, which is best tied to the stem. By selecting the temperature of reference a little higher than the highest temperature of the water supplied by the laboratory hydrants, it is easy to maintain the required temperature within a degree by regulating the flow. The instrument may then be adjusted to the tubulature of a retort and used in fractional distillations.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 17, 1881.

Dr. Gilbert, F.R.S., Vice-President, in the Chair.

The following certificates were read for the first time:—G. W. H. Clements, A. B. Griffiths, W. F. Reid, D. B. Steuart, C. A. Still, J. W. G. Stevens, B. E. Smith.

It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society, December 1.

The Chairman then called on Dr. Gladstone to read a paper entitled "*Aluminium Alcohols* (*Part II. Their Products of Decomposition by Heat*), by J. H. Gladstone and A. Tribe. The authors recently described the formation of alcohols (*Journ. Chem. Soc.*, 1876 and 1881), in which basic hydrogen is replaced by aluminium. The present paper contains the results of their investigation of the products of decomposition by heat of these bodies. Ethyl Series:—Aluminic ethylate may be distilled *in vacuo*, but is almost wholly broken up near its boiling-point under the ordinary pressure of the atmosphere into alumina, ethene, and alcohol; a similar decomposition takes place with aluminic amylate. Phenyl Series:—If similar reactions take place in this series, simple ethers, $(C_n H_{2n-7})_2O$, and hydrocarbons, $C_6H_4C_7H_6$, &c., would be obtained. Aluminium Phenylate.—About 500 grms. of this compound were heated in a flask with a wide bent tube attached. It melted, and after some free phenol had passed over, a somewhat viscid yellowish brown liquid distilled. The residue consisted of charcoal, tarry matter, and alumina. The distillate was re-distilled, and then fractionated into three portions. The first portion, 52 grms., was principally phenol. The second, 160 grms., after purification, boiled at 249°; it was a colourless liquid, sp. gr. 1·0904, and had the composition $C_{12}H_{10}O$ (phenyl-ether). It solidified to a mass of colourless prismatic needles when immersed in a freezing mixture. The third fraction, 34 grms., a viscid brown liquid, containing grains of a yellow solid, was distilled many times; a colourless liquid was finally obtained, boiling at 280°, and condensing to a nearly white solid. This was purified by re-crystallisation from alcohol, when it melted at 97°, and sublimed slowly a little below this temperature. From its analysis and vapour-density its formula is probably $C_{13}H_{10}O$. Three bodies of this formula are known—fluorene alcohol, diphenyl-ketone, and its isomer. The present body does not correspond in its properties with either of these three. It is probably a phenyl-ketone. It appears, therefore, that half of the phenylate was resolved by heat into phenyl-ether and alumina, that a small quantity of a compound,

$C_{13}H_{10}O$, was formed, and that about a quarter of the phenylate was resolved probably as follows:—

$$(C_6H_5O)_6Al_2 = Al_2O_3 + 3C_6H_6O + 3C_6H_4.$$

No evidence of the existence of the hydrocarbon C_6H_4 was obtained. In a similar way, the authors have examined the action of heat on aluminium para-cresylate. As compared to the decomposition of the phenylate, a smaller quantity of the ether and a larger quantity of a body, $C_{15}H_{14}O$, were obtained. The hypothetical hydrocarbon, C_7H_6, was not found. Aluminium thymolate is readily resolved by heat into aluminium meta-cresylate and propylene, the meta-cresylate being in its turn resolved into alumina, meta-cresol, meta-cresyl-ether, and a pearly compound, $C_{15}H_{14}O$, which is apparently isomeric with the body of the same formula obtained from the para-cresylate. Two substances of the formula $C_{15}H_{14}O$ (para-ditolyl and dibenzyl-ketones) are known, but their properties do not agree with either of these substances. The authors are inclined to consider these bodies as ketones, and provisionally as para- and meta-cresyl-ketones. Aluminium β-naphthylate.—The principal product of the decomposition is β-naphthyl ether—

$$(C_{10}H_7O)_6Al_2 = Al_2O_3 + 3\left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\}O.$$

Aluminium α-naphthylate.—This body requires a higher temperature than the β compound to effect its decomposition. The principal product formed has the formula $C_{20}H_{14}$, and resembles in physical properties the β-β-dinaphthyl of Watson Smith. It is doubtful whether an ether is formed at all by the splitting up of the α body.

Mr. E. Wethered read a paper entitled "*On the Chemical Action of Decomposing Vegetable Matter on the Rock-forming Sediment of the Carboniferous Period.*" The carboniferous rocks of the West of England above the limestone consist of an alternation of arenaceous and argillaceous strata with seams of coal. The arenaceous strata are of two types—the millstone and the Pennant grit. In almost every case the argillaceous strata immediately follow seams of coal, and in the exceptions where a grit occupies this position it becomes, in contact with carbonaceous matter, more or less argillaceous. In this paper the author endeavours to show that the argillaceous rocks, as compared with the Pennant grit, have been originated by the action of certain products of decomposition, given off from decomposing vegetable matter, on the original sediments of which the rocks have been built up. The author then compares analyses of several samples of Pennant grit with analyses of argillaceous strata, and shows that the principal difference between the two is in the alumina; while the Pennant grit contains 2 to 5 per cent of Al_2O_3, the argillaceous strata contain 9 to 16 per cent. In cases where a grit overlies seams of coal, it approaches, as it comes in contact with the carboniferous matter, in its characters, the argillaceous rocks. Thus the Doxall grit of the Bristol district, away from the coal, contains 5·5 per cent; close to the coal, 8·5 per cent of Al_2O_3. As another instance, the Great Vein stone, from the same district, away from the coal, contains 4·46 per cent Al_2O_3; close to the coal, 11·2 per cent. As a third example, two beds of Pennant grit were chosen, exactly similar, except that one contained stratified layers of carbonaceous matter, which were absent in the other. The bed free from carbonaceous matter contained 2·26 per cent, the other 7·11 per cent Al_2O_3. In every case, the grit becomes more argillaceous as it comes into contact with carbonaceous matter. The author has taken care that the samples compared should be of the same degree of fineness of grain, and is disposed to attribute this difference in chemical composition to the action of carbonic acid given off by the decomposing vegetation on the freshly-formed deposits of inorganic sediment. The carbonic acid would decompose all silicates, except the silicate of alumina, the bases forming soluble carbonates, and thus the alumina would increase in proportion to the whole, and the deposit become more argillaceous. The argillaceous rocks are also characterised by containing small quantities of sulphur, phosphorus, and manganese. The presence of these elements is attributed by the author to the power which plants have of secreting certain inorganic substances.

Prof. Church suggested that the increase in the alumina might be due to lycopodiaceous vegetation, as it was well known that the ashes of these plants contained much alumina.

Mr. Wethered could not agree with Prof. Church, because there are no remains of such plants in the argillaceous rocks, and because the alumina always increased whenever the grits came into contact with carbonaceous matter.

The Secretary then read a paper "*On α- and β-Amylam*," by C. O'Sullivan. Finely-ground skinless barley was treated with alcohol (sp. gr. 0·9 at 40°) as long as anything was dissolved. The residue was freed from alcohol, and treated with water at 35° to 38° for several hours. This extraction was repeated until nothing further was dissolved. The solution was filtered, evaporated, and precipitated with alcohol. The precipitate, which was white and stringy, was washed with alcohol, and dried. The powdered precipitate was extracted with cold water, and the crumby residue treated with cold dilute hydrochloric acid, washed, and then dissolved in boiling water, the solution filtered, and precipitated with alcohol containing 3 to 4 per cent hydrochloric acid. The precipitate was washed and dried, purified by re-solution and re-precipitation, and finally analysed after it had been proved by fractional precipitation that it contained but one substance. It has the formula $C_6H_{10}O_5$. A 1 per cent solution has rotatory power $[\alpha] = -24$; is almost insoluble in cold, and gelatinises in hot, water. It does not reduce alkaline copper solution. When boiled with 5 per cent sulphuric acid it is converted into dextrose without the formation of any intermediate products. This substance is distinct from Lippmann's lævulam, and is named by the author α amylam. The cold water extract of the crumby residue mentioned above was treated in a manner somewhat similar to that just described, and furnished β-amylam. It has the formula $C_6H_{10}O_5$; is soluble in cold water; has for 1 per cent solution $[\alpha] = -73$; and yields a birotatory modification (1 per cent sol. $\alpha = -144$). By the action of sulphuric acid it is converted into a dextrose, which resembles ordinary dextrose in cupric oxide, reducing power, and opticity, but has less tendency to crystallise. Barley contains about 2 per cent of α-amylam, and 0·3 per cent β-amylam. Wheat and rye contain 2 to 2·5 per cent of β-amylam, and not more than 0·1 per cent of the α body. Malted cereals do not contain these bodies.

Dr. Gilbert suggested that more or less perfect maturation of the grains might affect the quantities of these carbohydrates.

Dr. Armstrong drew attention to the paper as the result of a very large number of experiments. The author had established very clearly that these carbohydrates were converted directly into dextrose, when heated with dilute sulphuric acid, and thus differed most materially from ordinary starch.

"*On the 'Steeping' of Barley*," by E. J. Mills and J. Pettigrew. The authors have investigated carefully the action of distilled water, and of water containing known quantities of calcium sulphate and calcium carbonate on barley. The temperatures varied from 4° to 11°. The general results obtained are that water in which barley has been steeped contains at least two albumenoid bodies, one of which is thrown down by meta-phosphate (a quantity of sodic meta-phosphate is covered with acetified water and occasionally shaken; the clear liquid over the undissolved salt is the reagent) in the cold, the other only on boiling. The first of these is almost wholly kept back within the grain by a gypsum solution, and to a less extent by a chalk solution. The general effect of a calcic solution is to keep back the nitrogenous matter within the grain, but to increase the total amount of matter extracted. The authors examined the Burton water from Lichfield, which is in

much demand for steeping, and attribute its value to the nitrates it contains, which stimulate the germination. On the whole, the authors recommend for steeping a water containing 0·1 per cent of gypsum, and a small quantity of calcic nitrate. They suggest that with soft waters just enough water should be used to saturate the grain and no more.

"*On the Action of Oxides on Salts (Part IV. Potassic Chlorate and Ferric Oxide)*," by E. J. Mills and G. Donald. The authors give details as to the preparation of the two substances. The experiments consisted in heating a known weight (5 grms.) of the chlorate with varying quantities of ferric oxide to about 195° for about four hours. The oxygen expelled gave a measure of the reaction which had taken place. The authors conclude that this case of chemical change presents nothing unusual or peculiar in its features, and that the entire course of the action of ferric oxide upon potassic chlorate is strictly analogous to the first stage of the action of that oxide on potassic carbonate: from the carbonate an oxide of carbon is expelled, from the chlorate an oxide of oxygen. The name Catalysis therefore ceases to have any reason for its existence.

In a supplementary note E. J. Mills and John Stevenson have examined the action of manganese dioxide upon potassium chlorate, which also resembles the ordinary behavious of an oxide towards a salt.

The Society then adjourned to December 1, when a ballot for the election of Fellows will be held, and a paper by Dr. Armstrong, entitled "Researches on the Laws of Substitution in the Naphthalene Series," will be read.

NOTICES OF BOOKS.

The Student's Hand-book of Chemistry, with Tables and Chemical Calculations. By H. Leicester Greville, F.I.C., F.C.S. Edinburgh: E. and S. Livingstone.

The author of this work begins his preface with the very truthful remark that "in the presence of so many good manuals on chemistry the appearance of another may seem unnecessary." He ventures, however, to hope that his book will be of use to the student. Such a result is, of course, by no means impossible. But as far as all other subjects are concerned, the very first question asked by a publisher concerning a work proposed to be brought out is, what new and distinctive ground does it cover? As regards elementary works on chemistry, this rule, it seems, does not apply. Such manuals can scarcely do other than reproduce each other, with some very slight differences in arrangement, in wording, and in extent. The most noteworthy feature of the present volume is that it is non-examinational. The author includes in his scheme the whole of chemistry, physiological and analytical.

Adolph Strecker's Short Text-book of Organic Chemistry. By Dr. J. Wislicenus, Professor of Chemistry in the University of Würzburg. Translated and Edited, with extensive additions, by W. R. Hodgkinson, Ph.D., and A. J. Greenaway, F.I.C. London: Kegan Paul, Trench, and Co.

We have here a case of compound authorship in which the respective shares of the original author, of the German editor, and of the English translators are not easily traced. Strecker, it appears, died suddenly in 1871, as he was about beginning a sixth edition of the work. The revision of the book, and its adaptation to the present state of knowledge, fell to the lot of Prof. Wislicenus, who is not unknown in this country, especially to the readers of Kolbe's *Journal für Praktische Chemie*. Messrs. Hodgkinson and Greenaway have made alterations chiefly in the section dealing with the hydrocarbon compounds, and as regards the naphthalene compounds they have introduced the symbols of Reverdin and Noelting. The classification adopted in the volume before us is substantially as follows:—Cyanogen compounds: guanidin; derivatives of carbonic acid and carbon disulphide; the ethans or paraffins; their mono-, di-, tri-, and tetra-substitution derivatives; the respective derivatives of the pentavalent, hexavalent, and heptavalent hydrocarbon nucleus; the derivatives of the hydrocarbon nuclei, $C_nH_{2n}-6$; the aromatic compounds; homologues of benzene; the aromatic alcohols, aldehyds, ketones, and glycols; acids and their substitution products; further simple benzene derivatives; compounds of conjugated benzene nuclei; compounds containing condensed benzene nuclei; organic compounds of unknown constitution, and protein compounds. In an appendix are given the refraction equivalents of organic compounds, and an account of the diazo colours, the latter by Mr. R. Meldola—a high authority on the subject.

The descriptions of the various substances are brief, as may naturally be expected when the whole vast field of organic chemistry has to be surveyed in something less than 800 pages, but general accuracy is unmistakable. As regards theoretical questions, we notice that the authors adhere to the hypothesis of Kekulé concerning the benzol—or, as they write it, benzene—nucleus. Something concerning the views of Prof. Wislicenus may be gathered from the following passage in his preface:—"In the present state of our science we cannot neglect the frequent use of structural formulæ based on the valency of the chemical elements. Their partial uncertainty, and in many points tangible shortcomings, need not prevent their use to some extent in a text-book, though their use requires care. With regard to the manner of uniting the constitutional formula, no dogmatic adherence to any single method will be adopted, so that the formula of one and the same substance may be found varyingly written in different places. With every one of these systems of formulæ there is the danger of substituting a concrete image in place of an idea. These images we certainly cannot do without, but we must keep the idea lying behind such an image as far as possible pure and also mobile, seeing that in comparison with older views we have in it relative and not absolute truth."

We are far from regarding this passage as a model of scientific English, and if some portions of it do not read better in the original German we fear they may possibly be immortalised in Prof. Kolbe's *Chemische Blumenlese*.

We notice "maclurine"—an objectionable name—used instead of moreine, and on page 726 we find "phlorogulein" written for "phloroglucin,"—the only typographical error we have met with in the volume. There is a copious table of contents, and the index is full and accurate wherever we have tested it. As a fairly complete compendium of organic chemistry in the space of a single volume there was room for this work in our scientific literature, and we have no doubt but that it will be found useful.

Elementary Treatise on Natural Philosophy. By A. Privat Deschanel. Translated and Edited, with extensive modifications, by J. D. Everett, F.R.S. Sixth Edition. London: Blackie and Son.

We have on a former occasion had the pleasure of examining an earlier edition of this work, and we then felt bound to record our high opinion of its value and merits. Since that time it has undergone certain not unimportant modifications, and has received the additions necessary to render it a faithful summary of physical science up to the date of publication. Many of our readers may possibly take exception to the term "Natural Philosophy" in the title. That term has never been in use in France, and in England it is more and more falling into disuse, whilst in German the signification of "Naturphilosophie" is something totally different. But though we should certainly have preferred the title "Elementary Treatise on

Physics" had the work been now making its first appearance in an English guise, yet we can well understand the translator's unwillingness to alter the name of a book which has already passed through five editions, and has won the approval of competent authorities.

The original purpose of the treatise, as stated in the author's preface, was to assist young men in qualifying themselves for University Degrees. For this object it is well adapted. But it is also well suited for the purposes of private study and self-instruction. It is likewise to be recommended to that ever-increasing class who, without undertaking the formal study of any department of physical science, may wish to make themselves acquainted with any physical subject which is attracting public attention. Such persons will find it particularly adapted to their wants from the clearness of the language, the sparing use made of algebra, and the number and excellence of the illustrations.

The general classification adopted by the author is as follows:—Dynamics (including mechanics, hydrostatics, and pneumatics); thermics; electricity, including magnetism; acoustics, and optics. We may here remark that no agreement has yet been reached on the arrangement of the branches of physics. Save that all place dynamics at the beginning, nearly every treatise adopts a different order.

As regards the alterations made in the present edition, it appears that Part I., treating on dynamics, has been rewritten. All accurate statements of quantities are now given on the centimetre-gramme-second system. Part II. (thermics) has been re-arranged and enriched with much additional matter, such as an account of Dine's hygrometer and Symon's "Snowdon rain-gauge"; a notice of Guthrie's results on the freezing of brine; recent results on the conductivity of rocks and of water; a description of the modern gas-engine, &c. Part III., treating on electricity and magnetism, has also received extensive additions, among which rank descriptions of Planté's secondary battery, of Wheatstone's bridge and conjugate branches, of the magneto-electric machines of Siemens and Gramme, of the telephone, microphone, and induction balance, &c. Though the whole forms a bulky volume, it must be remembered that a full account of every subject included in the range of physical science would require far greater space, and this accordingly the author and the editor have not attempted.

CORRESPONDENCE.

SYMBOLICAL NOTATION.

To the Editor of the Chemical News.

Sir,—I shall be much obliged if you or any of your readers will explain to me how Kekulé's defence of his symbol for the benzene ring (viz., that the double linkings are not fixed in position, but oscillate) can be made to apply to naphthalene. The generally received symbol for naphthalene is—

Now it will be seen that the double and single linkings cannot be made to vibrate backwards and forwards at the same time in both rings, without one of the carbon atoms having five affinities saturated, and as carbon atoms are supposed to have only four each, this is impossible.

There do not seem to be any well-founded objections to the symbol—

analogous to the benzene one,—

but I have never seen this given in any book.—I am, &c.,

Alfred Pagan.

St. John's College, Cambridge,
October 11, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 17, October 24, 1881.

Detonation of Acetylen, Cyanogen, and of the Endothermic Compounds in General.—M. Berthelot.—Gases whose formation is attended with the absorption of heat, such as acetylen, cyanogen, arsenic hydride, which do not detonate on mere heating, may be brought to explode under the influence of a sudden and very violent shock, such as that which results from the detonation of mercury fulminate. This shock, indeed, only acts upon a certain layer of gaseous molecules, to which it communicates an enormous *vis viva*. By this shock the molecular edifice loses the relative stability, which is due to an especial structure.

General Determination of the Tension and the Volume of Saturated Vapours.—R. Clausius.—A mathematical paper, not admitting of useful abridgment.

An Apparatus for Determining without Pain to the Patient the Position of a Projectile of Lead or other Metal in the Human Body.—A. Graham Bell.—This memoir requires the two accompanying illustrations.

Electrolysis of Water.—D. Tommasi.—According to the author a zinc-copper or zinc-carbon element plunged into dilute sulphuric acid does not decompose water if the two electrodes are of platinum. In order that the electrolysis of water may take place, the positive electrode must be formed of a metal which, under the influence of the voltaic current is able to combine with the oxygen of the water.

A Compass of Proportion, for the Measurement of Resistances.—J. Carpentier.—Suppose, at the surface of a sphere, of which the vertical diameter is taken as polar axis, two identical circuits are arranged so as to follow the circumference of two meridians. A current passing by one of these circles exerts upon a magnetic pole, situate at the centre of the sphere, a force normal to the plane of this circle, and proportional to its own intensity. Another current, traversing the second circle,

determines at the centre of the sphere a second force perpendicular to the former. These two forces acting simultaneously combine; the direction of the resultant depends merely on the ratio of the two intensities, and this ratio of magnitude of one of the components to the other will be exactly measured by the trigonometric tangent of the angle α, formed by the resultant and the second component. Let us suppose a wire without torsion extended along the polar axis of the sphere, and fixed upon this wire, perpendicularly, in its middle, a very short magnetic needle. This needle thus suspended in the centre of the sphere will be free to turn in the plane of the equator. Under the double action of the currents it will take the direction of the resultant of the forces. Nothing will be easier than to measure the angle α above defined.

A New Hydrate of Carbon.—E. Morelle.—The author has examined bergenite, a crystalline principle, obtained from *Bergenia sibirica*, and which he finds to be a pentatomic alcohol.

Moniteur Scientifique, Quesneville.
August, 1881.

Venomous Matters produced by Man and the Higher Animals.—A. Gautier.—The author has extracted from normal human urine a well-characterised and highly poisonous alkaloid. In the venom of the *Trigonocephalus* and of *Naja tripudians* (the Cobra), he has detected two alkaloids. In that of the cobra he has also found a second principle, still more poisonous, but not basic.

Researches on Conquinamine.—A. C. Oudemans.—From the *Archives Neerlandaises*, vol. 15.

Alkaloid extracted from Pituree.—Prof. Liversidge.—Translated from the English original.

Report presented by M. Vincent on a Communication from the French Celluloid Company.—From the *Bulletin de la Société d'Encouragement.*

Certain New Methods of Desulphurising Alkaline Solutions.—Scheurer Kestner.—The means employed for removing sodium sulphide from the lixivium of the black ash are precipitation of the sulphur as a metallic sulphide by the addition of metallic salts or oxides; the use of neutral alkaline salts, the property of which is to free the solution from a certain quantity of iron sulphide, and lastly oxidation-methods. Total desulphuration is generally effected by oxidation, set up by a current of air forced through the liquid. Hargreaves, in 1866, called attention to the oxidation of the liquid by means of a current of steam. Pauli has improved upon this process, and adds to the liquids to be oxidised a small quantity of manganese dioxide. This addition accelerates the oxidation in the proportion of 1·7 : 1. When air is used as an oxidising agent the liquid should be heated to about 75°. This oxidation ceases with the formation of sodium hyposulphite. If manganese is added, a portion of the hyposulphite is transformed into sulphate, but never the whole. If it is required to obtain solutions free from the lower oxides of sulphur, oxidation by electrolysis is preferable, as patented by Merle. The sodium sulphide is transformed into sodium sulphate without passing through the intermediate stages.

Journal de Pharmacie et de Chimie.
August, 1881.

Researches on Nitrogen Sulphide.—MM. Berthelot and Vieille.—From the *Comptes Rendus.*

Determination of Gluten in Flour.—MM. Bénard and J. Girardin.—The authors find that the length of time between the preparation of the paste and the extraction of the gluten decidedly affects the results.

Assay of Commercial Wood-Spirit intended for the "Denaturation" of Ethylic Alcohol.—C. Bardy.—For the assay of a commercial methylene the author takes, by means of a pipette, 5 c.c. of the sample in question, and introduces them into a flask holding 50 c.c., which is then immediately filled with water up to the mark. The flask is then closed with the finger and shaken vigorously. 10 c.c. of this liquid are then taken with a pipette, and let flow into a litre flask, which is then filled with water up to the mark, closed with the palm of the hand, and shaken well. A solution of methylene at 1-1000th is thus obtained. To make the assay, the author takes 5 c.c. of this dilute liquid with a pipette, pours it into a test-tube (graduated at 5, 15, and 30 c.c.). He adds a standard solution of soda (sp. gr. 1·080) up to the mark 15 c.c., and then introduces half a c.c. of the standard solution of iodine (a solution of 254 grms. iodide to 385 grms. potassium iodide, and made up with water to 1 litre). He closes the tube with the thumb, and reverses it *once* to mix the liquids. There is instantly produced a milky turbidity, due to the formation of iodoform. The tube is then filled up with water to the mark 30 c.c. It is inverted once, and is then compared with a tube made up in the same manner with a standard sample of methylic alcohol.

Distinctive Reactions of Santonine and Strychnine.—Colin Tocquaine.—Treatment with sugar and sulphuric acid gives the same result with both. But if the mixture is then treated with a drop of officinal tincture of iodine, and then with an excess of acid nitrate of mercury, there is produced with strychnine an intense brown colouration, but with santonine, a white precipitate, which becomes in time slightly yellow.

The Separation of Wool and Silk in Woven Goods.—A. Rémont.—The following method is sufficiently exact for commercial purposes:—The sample is kept for a quarter of an hour in boiling water containing 5 per cent of hydrochloric acid, and is then washed and dried. The threads of the warp are then separated, if possible, from those of the weft, and examined separately as follows:—A thread is burnt. There is given off a smell like burning horn, and a thread heated with a fragment of caustic soda evolves ammonia. In this case some threads are plunged in basic zinc chloride at a boil. If they dissolve completely the threads are *silk*. If on adding hydrochloric acid there is a plentiful flocculent precipitation, the threads are silk mixed with wool or with vegetal fibres. If nothing dissolves in zinc chloride, the threads are plunged in a boiling solution of soda, not too concentrated. If they dissolve completely, *wool*. If partially, *wool* and *cotton*. If no odour of burnt horn is given off, the threads consist entirely of vegetal fibres. These results may be confirmed by means of the microscope. For the quantitative examination, if the preliminary tests show silk, wool, and cotton, four swatches weighing each 4 grms. are cut; one is laid aside and the three others are boiled.

Determination of the Dressing and the Dye.—The swatches are plunged into 200 c.c. of hydrochloric acid diluted to 3 per cent, and heated to a gentle boil, which is kept up for a quarter of an hour. If the liquid is deeply coloured, it is poured off, and fresh acid is substituted, which is again boiled for a quarter of an hour. The swatches are then washed in water, and dried by wringing them in a piece of linen. The purpose of this boiling is to remove the dressing. As for the dye which colours the fibres, it is easily removed from cotton by this process; less readily from wool, and from silk very incompletely. When the latter material is dyed light shades by means of the coal-tar colours, the weight of the dye is trifling, and may be neglected. It is not the same if the silk is dyed deep colours, and especially black. The weighting or loading may be completely removed from iron if it does not exceed the fourth of the weight of the thread, and the colour of the latter borders on a maroon. Beyond this proportion the stripping of the dye is incomplete. An approximate idea of the weighting retained by the tissue may be got by afterwards incinerating the boiled swatch.

If the proportion of oxide of iron remaining is slight, it may be overlooked, but if it reaches 5, 8, or 10 per cent, calculated on the weight of the silk in the cloth, it must be taken in account.

Separation of the Silk.—One of the boiled swatches is set aside, and the two others steeped for a minute or two in a boiling solution of basic chloride of zinc at 60° B. (J. Persoz). M. Morin prepares this reagent by heating the following mixture till dissolved:—

Melted zinc chloride..	1000 parts.
Distilled water	850 „
Zinc oxide	40 „

The two swatches are, when drained, thrown into a glass of water, where the greater part of the salt of zinc is separated. They are then washed with acidulated water, and then with plain water till the washings no longer give a precipitate with ammonium hydrosulphate.

Separation of the Wool.—One of the two swatches freed from silk is put aside, and the other is steeped in 60 to 80 c.c. of soda-lye of specific gravity 1·020. It is heated to a gentle boil, which is kept up for a quarter of an hour. The bulk of the liquid must not be allowed to decrease, and in washing and drying the residue it must not be rubbed lest losses be occasioned by the breaking of the fibres.

Drying and Weighing the Swatches.—The four swatches are placed in a drying oven heated by boiling water. After the lapse of an hour they are taken out and exposed to the air in the place where the sample was originally kept. They are weighed the next morning. The swatch which has undergone no treatment should weigh 2 grms., a difference of 0·005 grm. more or less may be neglected, but beyond this figure the change of weight should be taken into account in the calculation. The difference between the weight of this swatch and that of the one merely treated with acid gives *dressing and dye*. From the weight of this second swatch deduct the weight of that treated with zinc chloride and it represents *silk*. As for the fourth swatch it represents approximately all the *vegetable fibre*; approximately, for soda, even in dilute solution, attacks vegetable fibres, so that a correction must be made in the weight found. From numerous trials made it appears that the average loss of cotton on treatment with soda is 5 per cent. On adding to the fourth swatch 5 per cent of its weight, we have the cotton. The figures found are multiplied by 50 to bring the result to percentages. The difference between the sum of these figures and 100 gives the weight of wool.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, July 28, 1881.

M. Tommasi pursues with success the construction and the trials of his secondary horizontal battery.

M. Moigno agrees with Mr. C. Latimer, that in a few years the mètre will be rejected, even in Paris, in favour of the cubit of the great pyramid.

Dissociation of Sulphuric Acid.—MM. J. Kœchlin and Gerber.—The authors support the hypothesis of M. Maumené that sulphuric acid when heated is partially dissociated into sulphuric anhydride and water, and these two bodies do not immediately re-combine when the liquid is suffered to cool.

No. 15, August 11, 1881.

Reaction of Bi-imido-naphthol with Aqueous Ammonia.—MM. Ludwig and Mauthner.—The results of the reaction are the same as those yielded by the treatment of oximido-naphthol, though mixed with a small quantity of a substance resulting from the contact of oximido-naphthol with hot water.

Oxalates of Iron.—MM. Eder and Valenta.—The authors describe a yellowish green normal oxalate, a red-brown basic salt, and three double salts containing three molecules of alkali.

Action of Light upon Ferric Chloride and other Ferric Salts.—J. M. Eder.—The ferric oxalates, citrates, and tartrates, and their double salts, as also the mixtures of ferric chloride with organic matter, are all decomposed by the action of light.

Resin of Guiacum.—H. Wieser.—Not suitable for abstraction.

Resins.—K. Bötsch.— So-called dragon's blood, if heated with zinc powder, yields styrol, meta-styrol, and ethylated benzol. Guiacum resin if similarly treated yields creosote, toluol, meta- and para-xylol, and a smaller proportion of pseudo-cymol.

MISCELLANEOUS.

The Reduction of Copper Solutions by Glucose* appears first to have been utilised by Trömmer. Frommherz suggested the employment of a citrate to keep the cupric oxide in solution. Modifications of the ordinary alkaline tartrate solution have been devised by Barreswil, Poggiale, Rosenthal, Chevalier, Boussingault, Reveil, Fehling, Strohl, Viollette, Magneshahens, Lowenthal, Joulie, Possoz, &c. Loewe employed glycerin instead of a tartrate. Various treatments of the precipitated cuprous oxide have been proposed by the following chemists:—Mohr disolves the oxide in hydrochloric acid, and titrates with permanganate. Brunner dissolves in an acid solution of ferric chloride, and estimates the reduced iron by bichromate or permanganate. Champion and Pellet dissolve the precipitate in hydrochloric acid and chlorate of potassium, boil off free chlorine, and titrate the liquid with stannous chloride. Girard and Soxhlet reduce the cuprous oxide in hydrogen, and weigh the metallic copper. Muter dries the cuprous oxide at 100° C., and weighs it as Cu_2O. O'Sullivan and other operators ignite the precipitate strongly, and weigh as CuO. Ferdinand-Jean dissolves the cuprous oxide in hydrochloric acid, and weighs the metallic silver precipitated on adding ammoniacal silver nitrate. Maumené uses an excess of copper solution, filters, adds ammonia to the filtrate, and estimates the residual copper by titration with sodium sulphide, for which Perrot substitutes potassium cyanide. Lastly, Pavy adds ammonia to the alkaline cupric solution, and runs in the sugar solution till the hot liquid is decolourised.

Cantor Lectures.—On Monday evening last (21st inst.), the first lecture of the first course was delivered by Mr. Thomas Bolas, F.C.S., the subject being "Some of the Industrial Uses of the Calcium Compounds." Mr. Bolas alluded to the distribution and occurrence of calcium in nature, and the abundant existence of carbonate of lime as limestone, chalk, marble, calcspar, shells, &c. He referred to the new metallurgy of Davy, as initiated by the isolation of potassium; and pointed out the probability that some of those metals which are abundant, but not in general use, may soon come into notable importance. In conclusion, some of the most important points in the general chemistry of the calcium compounds were demonstrated. The isolation of the metal calcium by the electrolytic decomposition of its fused chloride was shown experimentally, the necessary electric current being furnished by a machine constructed on Pacinotti's principle, and driven by a small gas motor.

Photographic Exhibition.—The substitution of a film of dried gelatin for the thin layer of wet collodion, which the photographer formerly employed as a vehicle to retain the sensitive salts of silver in a suitable condition on his glass plate, has involved considerable alterations in the mechanical appliances used in photography. For out of doors work, or work away from home, the photographer no longer requires to carry what was practically a portable laboratory. Not having to "develop" his pictures on the spot, he need take with him neither dark tent nor

* From an Advance-Sheet of Allen's "Commercial Organic Analysis," vol. ii.

chemicals. On the other hand, he must have some provision by which his store of dry plates can be placed, one after the other, in the camera and properly "exposed" without the risk of the slightest particle of light reaching their sensitive surface, other than the light properly directed upon them by the lens. As he wishes to carry an ample supply of plates with him, and as the glass plates themselves make an appreciable burden in a long walk, it s essential that the apparatus for carrying them should be as light as possible; hence have arisen considerable improvement in the camera and its "slides." Again, the increased sensitiveness of the gelatin films makes it possible to give exposures shorter than can be effected by the hand uncapping and re-capping the lens; hence the invention of numerous "instantaneous shutters," by which exposures of a few hundredths of a second can be given, and pictures of moving objects readily secured. These are but instances of the many novel appliances which recent progress in photographic science has originated, and, besides these, there has been, during recent years, many and important improvements in the applications of photography to the production of permanent illustrations for books and newspapers. All these varied applications of the art are to be illustrated by an exhibition of photographic appliances which the Council of the Society of Arts announce will be held during January and February next, in connexion with a course of Cantor lectures to be given before the Society by Capt. Abney. Full particulars of this exhibition are given in the *Journal of the Society of Arts* for last week.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Evaporation.—Can any of my fellow readers inform me if the patent for the "Porion Evaporator" (1865) has expired?—MURIATE.

Barcenium.—Can you or any of your readers favour me with some reference to the newly-discovered element Barcenium? I have recently seen casual allusion to it, and can find no account of its discovery, properties, &c.—H. C. B.

Vegetable Parchment.—Will any of your readers kindly afford information as to the best cements for dialysers, &c., made of vegetable parchment? The cement should withstand the action of hot liquids.—DIALYSIS.

MEETINGS FOR THE WEEK.

SATURDAY, 26th.—Physical, 3.
MONDAY, Nov. 28th.—Medical, 8.30.
— Society of Arts, 8. "Some of the Industrial Uses of the Calcium Compounds," by Thos. Bolas, F.C.S.
TUESDAY, 29th.—Institute of Civil Engineers, 8.
WEDNESDAY, 30th.—Society of Arts, 8. "The Distribution of Time by a System of Pneumatic Clocks," by J. A. Berly.
— Royal, 4. Anniversary.
THURSDAY, Dec. 1st.—Chemical, 8.
FRIDAY, 2nd.—Geologists' Association, 8.
— Society of Arts, 8. Discussion on the Society of Arts Patent Bill.

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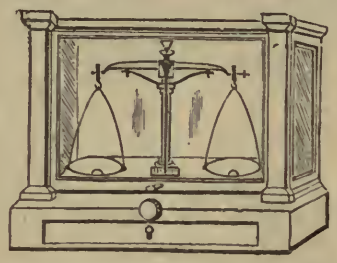
ROTTERDAM.  NEW YORK.
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THE CHEMICAL NEWS.

VOL. XLIV. No. 1149.

DETECTION OF STARCH SUGAR SYRUP MIXED WITH SUGAR-HOUSE MOLASSES.*

By P. CASAMAJOR

IN previous communications I have given processes for detecting the adulteration of cane-sugar by starch-sugar. The adulteration of sugar-house syrups by starch glucose is still more extensively practised than that of sugar, and a great portion of the syrups sold by retailers in this market is adulterated with starch glucose. This form of adulteration may be very easily detected by the use of strong methylic alcohol, in which the alcohometer of Tralles or of Gay-Lussac will indicate about 93½°.

A straight sugar-house syrup when mixed with three times its volume of this strong methylic alcohol will dissolve by stirring, giving a very slight turbidity, which remains suspended; while syrups containing the usual admixture of starch-sugar give a very turbid liquid, which separates, when left at rest, into two layers, the lower being a thick viscous deposit containing the glucose syrup.

Considerable quantities are sold of a thin syrup, of about 32° Baumé, in which the proportion of sugar to the impurities is greater than in common sugar-house molasses. When a syrup of this kind is stirred with three times its volume of methylic alcohol, a marked turbidity and deposition will take place, which consists of pure sugar. The crystals are hard and gritty. They adhere to the sides of the glass, and are deposited on the bottom. There is no resemblance between this precipitate and that due to starch-sugar syrup.

It may not be useless to mention that if a straight sugar-house syrup of about 40° B. density is stirred with three times its volume of *ethylic* alcohol of about 93½° the syrup will not dissolve. Hence ethylic alcohol of this strength is not suitable for distinguishing a syrup mixed with starch glucose from a *straight* sugar-house syrup.

The presence of starch glucose in sugar-house molasses may be easily detected by the optical saccharometer when the syrup has the usual density of about 40° B., and when starch-sugar has been added in the usual quantities.

For making the test the usual weight should be taken (16·35 grms. for Duboscq's saccharometer, and 26·048 grms. for Ventzke's instrument). The direct test should show a percentage of sugar not higher than the number of Baumé degrees indicating the density, and it may be from 2 to 3 per cent lower. To understand this, we must refer to the composition of cane-sugar molasses of 40° B.:—

Sugar	37·5
Insoluble impurities	37·5
Water	25·00

If the direct test should indicate 55 per cent of sugar, and if the molasses were straight, the composition would be—

Sugar	55
Soluble impurities	20
Water	25

Now a product of this composition would not be a clear syrup at 40° B., but a mixture of syrup and crystals. Therefore if the product is a clear syrup at 40° B., and it tests 55 per cent, it cannot be *straight*.

The presence of starch glucose in sugar-house molasses may also be detected by the copper test. The possibility of applying this test, as well as those already indicated, rests on the fact that starch glucose is always added in very large quantities for the purposes of adulteration. A very small addition could not be satisfactorily detected.

The detection by the copper test rests on the observation that very nearly one-half of the soluble impurities in sugar-house molasses consists of glucose in the shape of inverted sugar. We have seen above that for a molasses of 40° B. the soluble impurities amount to about 37½ per cent. We may, then, lay down the rule: that the percentage of glucose shown by the copper test cannot, in a straight sugar-house molasses, be much greater than one-half of the number expressing the density in Baumé degrees. The reason is obvious from what has been said of the test by the optical saccharometer.

* A Paper read before the American Chemical Society, September 2, 1881.

ATOMIC PHYLLOTAXY.

By PLINY EARLE CHASE.

GERBER (CHEMICAL NEWS, vol. xliii., p. 242-3) says that "no simple relation exists among" his divisors, therefore they "have no value in themselves." There is, however, a relation which he failed to discover, for they are phyllotactic, as will be seen by the following comparison:—

Gerber.		Phyllotactic.	
H ..	0·9997	1-16 O ..	0·998
D_1 ..	0·769	$D_1 = 5\text{-}13\ D_2$ ..	0·768
D_2 ..	1·995	$D_2 = \frac{1}{2}$ O	1·996
D_3 ..	1·559	$D_3 = (\frac{1}{2} \times \frac{2}{3})^2$ O ..	1·559
D_4 ..	1·245	$D_4 = \frac{2}{3} D_2$	1·247

These relations may have an important bearing upon the interpretation of frost crystals and protective mimicry.

Haverford College, Pa., Nov. 10, 1881.

RELATIVE PURITY OF THE CITY WATERS IN THE UNITED STATES.

By Dr. A. R. LEEDS.

A LEGAL suit has recently been instituted, which will probably have a very important bearing in the future upon the quality of the water supplied to many of the principal cities in the United States. To understand more readily the nature of the questions raised in this suit, a few words of previous explanation will be requisite. The three cities of Newark, Jersey City, and Hoboken, with an aggregate population of 300,000 inhabitants, all draw their water supply from the river Passaic. This is a large stream, having a daily flow at Newark of about one million gallons. Its water-shed is mainly granitic in character, and occupies about 950 square miles in the northern part of the state of New Jersey. About 3 miles above the City of Newark, the Belleville pumping-stations are located, and at this point the supplies of the three above-mentioned cities are taken. Some 18 miles farther up the stream is the town of Paterson, a community almost entirely engaged in the manufacture of paper, cotton, woollen, and silk goods, locomotives, &c., and which throws its entire refuse and the sewage of 50,000 inhabitants into the Passaic. Above Paterson there are few villages and factories, so that the water going over the Great Falls at this place is of superior quality for drinking purposes. Below Paterson manufactories are gradually springing up, and are a constant source of uneasiness and alarm to the large population using the water as pumped at Belleville. During the course of the year just passed, one of these factories, an extensive paper-mill, situated on the Third River, a small tributary emptying into the Passaic a short distance above Belleville, threw into the water the refuse derived from washing out some carbolised

COMPARISON OF CITY WATERS

June 23, 1881.	Hoboken. 1.	2.	3.	4.	Jersey City. 5.	6.	7.	8.	9.	10.
Free ammonia	0·002	0·0024	0·0022	0·0033	0·00475	0·00525	0·005	0·003	0·0045	0·0075
Alubmenoid ammonia	0·0305	0·0285	0·0328	0·0290	0·0427	0·0403	0·03775	0·0293	0·0423	0·042
Oxygen required	0·36	0·85	0·965	0·83	0·95	0·85	0·73	0·84	0·9	0·85
Nitrites	none	none	none	none	none	none	none	none	none	none
Nitrates	0·6845	0·666	0·702	0·6845	0·9065	0·629	0·6845	0·666	0·702	0·7585
Chlorine	0·26	0·215	0·27	0·305	0·235	0·215	0·225	0·230	0·210	0·220
Total hardness	3·20	3·30	3·00	3·050	3·200	3·000	3·100	3·200	3·000	3·200
Total solids	12·20	15·60	3·50	7·400	9·300	10·800	9·700	10·000	10·800	10·500
Mineral matter	5·60	3·20	4·00	3·000	3·400	5·200	5·200	6·400	6·100	5·900
Organic and volatile matter	6·60	12·40	4·50	4·400	5·900	5·600	4·500	4·000	4·700	4·600

paper. The taste and odour of carbolic acid were so strong that they caused a temporary suspension of the use of the Newark, Jersey City, and Hoboken water for drinking. The Newark Aqueduct Board summoned the parties to desist, which they did at the time, but afterwards repeated the offence, when suit was brought against them by the Board. In defence, the plea was entered, and an attempt made to substitute it by the testimony of many manufacturers, that the water was already so badly polluted at Paterson that it could not be made more unfit for drinking purposes by the introduction of some carbolic acid. In fact, it was urged that so far from being rendered any worse by the carbolic acid, it was actually made better, for the reason that the carbolic acid served to purify and disinfect the water. The case was decided in favour of the Aqueduct Board.

The importance of having successfully established such a precedent can scarcely be over estimated in connection with its future influence upon the sanitary welfare of rapidly-growing communities. In this category are to be placed the large cities in the eastern and middle United States, nearly all of which are contending with one phase or another of the evils arising from the crowding in of population, and a population in many instances devoted to manufacturing, upon their sources of water-supply. As a consequence, the problem whether to abandon the original sources, which in most cases are those apparently designed by nature, and seek more distant and expensive ones, or to restrain the pollution by legal processes, is most urgent.

In this connection the author has been asked by the Boards of Water Commissioners of Newark and Jersey City to examine into the amounts of impurities in the river Passaic, beginning with a point above Paterson, and making analyses of samples collected at an interval of a mile, until the stream has passed the City of Newark. The collection was made all upon the one day, at the close of a period of many weeks of almost unexampled drought. The analyses of the forty samples thus collected will show not only the composition of the river-water in its worst condition, but likewise the changes in that composition during a flow of 21 miles.

Connected with this inquiry was the important one of determining the quality of the water-supply as compared with that of other cities. The design was to collect the samples on the same day, and analyse them all by the same methods. It was but partially successful, owing to a failure to obtain simultaneous co-operation in so many places. In the case of Washington, this was due to the fact that Dr. Smith Townsend, the Health Officer of the District of Columbia, at the very time of receiving my telegraphic request was summoned to attend the wounded President in the railroad station at Washington. In the great excitement and general distress the telegram was naturally lost sight of for several days. Neither was it a mode of comparison unexceptionable in point of principle, inasmuch as the climatic conditions were not exactly the same in the various places. So that from the results gathered it would be manifestly unfair to state that the order of purity was fixedly maintained as that given. It could only be said that at the time when the comparison was made, about the 1st of July of this year, such an order existed.

Together with these determinations, a number are given of the water of the River Passaic as delivered at widely different points, and at nearly the same time on the same day, in Jersey City and Hoboken. They show not inconsiderable differences in composition, and illustrate to what extent water may differ when flowing at very different rates of velocity, or in the case of dead ends scarcely at all, in one and the same system of distributing pipes. Nearly all these pipes were of iron, cement pipes being little used. The results given are in parts per 100,000.

The labour of making a comparison was greatly facilitated by plotting these results on a large chart, so as to form a graphic representation of them. From this the following order of relative purity was inferred:—

I. Brooklyn.
II. Rochester.
III. Philadelphia.
IV. Baltimore.
V. Washington.
VI. New York.
VII. Newark, J. City, Hoboken.
VIII. Cincinnati.
IX. Oswego.
X. Wilmington, Delaware.
XI. Boston.

In many particulars the order thus arrived at was quite unforeseen, and was a matter of great surprise. This was more especially true of Boston, which I anticipated would stand nearly at the head of the list, but which actually came at the bottom; and yet the water-sheds of both Brooklyn and Boston are upon drift gravel. A month later I found that the best hotels in Boston, and private citizens who were willing to be at the extra expense, were supplied by spring-water carted into the city and sold at the rate of 10 cents per gallon. This state of affairs continued until the 28th of August, when I visited the city

Mystic Lake.	Sudbury River. Farm Pond.	1st Dam.	Cochituate.	Pegan Brook.
Free ammonia—				
0·015	0·001	0·012	0·025	0·289
Alumenoid ammonia—				
0·032	0·0325	0·039	0·064	0·240
Oxygen required to oxidise:—				
Organic matters—				
0·90	1·18	1·19	0·83	6·63
Chlorine—				
3·01	0·46	0·44	0·46	7·65
Total solids—				
12·50	7·50	7·50	7·50	49·00
Mineral matter—				
8·00	4·00	4·00	5·00	24·00
Organic and volatile matters—				
4·50	3·50	3·50	2·50	25·00

IN THE UNITED STATES.

Paterson.	New York.	Brooklyn.	Boston.	Phila.	Wilmington.	Baltimore.	Washington.	Oswego.	Cincinnati.	Rochester.
June 23.	June 23.	June 23.	June 23.	June 24.	June 24.	June 25.	July 5.	July 9.	July 15.	July 23.
0·0025	0·0027	0·00075	0·01325	0·001	0·0035	0·005	0·006	0·0035	0·0115	0·0114
0·053	0·027	0·00825	0·0605	0·018	0·0295	0·020	0·027	0·0256	0·024	0·023
0·96	0·81	0·413	1·77	0·46	0·57	0·570	0·600	0·630	0·860	0·79
none	none	none	none	none	none	none	none	none	none	none
0·465	0·8325	1·2025	1·2395	0·6845	0·518	0·6100	0·8325	1·050	0·740	0·629
0·300	0·350	0·550	0·315	0·3000	1·45	0·275	0·270	4·100	0·805	0·195
3·000	3·300	2·270	2·100	4·400	3·200	3·900	4·800	10·000	6·400	5·500
11·700	11·800	6·000	8·500	14·300	10 000	9·400	11·500	18·070	16·200	10·000
3·500	5·000	5·000	2·000	6·000	3·000	7·200	5·500	11·370	9·000	4·000
8·200	6·800	1·000	6·500	8·300	7·000	2·200	6·000	6·700	7·200	6·000

again, and inspected the Cochituate Lake and the Sudbury and Mystic Rivers, the three sources of supply. The water in the reservoirs supplied by the two latter streams had a yellow colour and disagreeable musty taste and smell. During the earlier portion of the summer all the reservoirs had contained an abundant growth of algæ, which later on had decomposed, leaving behind the bad taste referred to. A striking peculiarity of these Boston waters is the large amount of decomposable organic matters held in solution. These points will best appear by examination of the results of analyses of samples collected on the 29th and 30th of August. (See Table at foot of preceding column).

The causes of the inferior character of the Boston water supply are, first, its pollution by a few manufacturing towns; and, secondly, the growth of algæ; which again, is favoured by the shallow character of portions of the reservoirs and impounded streams. The worst of these sources of pollution is Pegan Brook, which flows through the town of Natick, a town of ten thousand inhabitants almost entirely engaged in the manufacture of shoes, and empties into Cochituate Lake. The attempt has been made to mitigate the evil by throwing two filtering dams across the outlet of the stream, but both the fore-bays thus formed are densely over-grown with the lowest forms of aquatic vegetation, and may to a certain extent act as nurseries for the growth of these plants.

The Rochester water supply is derived from Hemlock Lake, remote from all sources of contamination, and after flowing through conduits for a number of miles is discharged through a noble fountain into a reservoir near the city.

A large portion of the Philadelphia supply is obtained from the river Schuylkill. At one time it was in imminent danger of fatal pollution from the growth of manufactures on the borders of the stream; but the City purchased the lands on both banks, nearly to the factory town of Manayunk, located about seven miles above, and included these lands in a great park so as to keep back all buildings from the water's edge.

New York and all the places mentioned lower on the list receive their water supply from contaminated sources. The feeders which empty into Croton Lake, the principal reservoir of the New York water, pass through a settled country, with numerous tanneries, factories, &c., along their banks. Analyses of the Croton water, made at different seasons during the past five years, have shown that it is to be classed among contaminated water supplies.

On the publication of the results above stated, it was indignantly claimed by the newspaper press of Wilmington, Delaware, that an injustice had been done to their city. But subsequently letters published in reply by citizens of the place have affirmed the correctness of the judgment formed on the analytical data, and have enumerated the various breweries, woollen, cotton, and other mills and dye-houses, as affording a sufficient explanation of the low position assigned to the water-supply.

In conclusion, it is worthy of mention that the different State Governments have passed, or are about passing, laws on the subject of the pollution of water supply, and these laws lean more and more strongly upon the side of public as against private manufacturing interests.

NOTE ON THE

RECOMBINATION OF THE SPECTRAL COLOURS BY A SECOND PRISM REVERSED.

By ALFRED W. SOWARD.

It is well known that if white light be passed through a prism a coloured spectrum is produced, and that if a second similar prism be placed in a reversed position in the path of the spectral rays white light is apparently reformed. But as to how this apparent recombination is effected, a very great misapprehension would appear to prevail. The subjoined figure (1), extracted from a well-known work on physics, well expresses the general belief as to the matter. A moment's consideration will, however, show the impossibility of the light passing through the

FIG. 1.

second prism as depicted. The adjacent sides of the two prisms being parallel to one another, it is evident that the rays 1—2 and 3—4 respectively, must also be parallel to one another; and if the angles be worked out for any particular case it will be found that they are so. Figure 2 then represents the actual state of affairs.

It follows from this that a second prism reversed has not the power of re-compounding the spectral rays to form white light, but merely of rendering them parallel. The

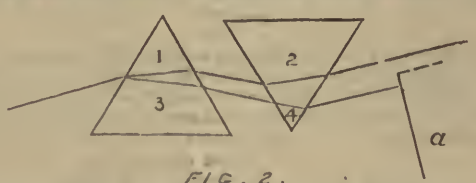

FIG. 2.

light incident upon the first prism is of the same composition throughout; if any portion be shaded off the residue is still white. Whereas the light emitted from the second prism has not a uniform composition; if one side be shaded off (as by the screen *a*) the residue is coloured.

That the light issuing from the second prism appears white is probably an effect due to the eye. Imagining the slit from which the light issues to be made up of a great number of physical points, each point would send forth its light, which would be decomposed by the first prism, rendered parallel by the second prism, re-compounded by

the lens of the eye, and focussed upon the retina as a white image of the physical point from which it emanated. In this way there would be built up upon the retina a white image of the slit.'

NOTICE OF A PHOSPHORUS OXYIODIDE.

By BEVERLEY S. BURTON.

HAVING frequently observed, on closely examining the residue in the retort after preparing ethyl iodide, minute golden scales, I was induced to examine these more closely. To this end the residue was treated with water and filtered from the excess of red phosphorus; the filtrate was then evaporated on the water-bath.

When quite concentrated, and allowed to cool, a quantity of granular red crystals was deposited, which were purified by drying on filter-paper and re-crystallisation untill all free iodine was perfectly removed. On one occasion the crystals were obtained much larger, with brilliant facets: the form was not determined. It is very soluble in water, alcohol, and ether, the solution being perfectly colourless. This property is made peculiarly striking when the dish is simply wet with the solution and placed on the water-bath, thus becoming almost instantly a deep orange colour to a beautiful scarlet, which again disappears when held a moment in the steam.

On heating, the crystals melt to a deep reddish brown crystalline mass, the melting-point being 140°.

By increasing the heat yellowish vapours are given off which blue starch-paper. These vapours condense on a cold surface as a yellowish red crystalline deposit, which behaves in all respects as the original body, *i.e.*, sublimes, in part, unaltered.

The portions used in the further examination were purified perfectly from all free iodine and dried over sulphuric acid. It being found that a solution of the body was conpletely decomposed by silver nitrate, the method of analysis was the following:—

An excess of silver nitrate was added to the solution, the separated silver iodide filtered off, and the excess of silver in the filtrate separated by hydrochloric acid. To the filtrate, free from silver, an excess of sodium carbonate was added, also a little sodium nitrate, then the whole evaporated to dryness and fused. The solution of the fused mass is then precipitated with magnesia mixture, any alumina or silica which might separate on addition of ammonia being previously removed.

The following results were obtained:—

	I.	II.
I	77·93	77·44
P	9·66	9·71
O	12·41	12·85
	100·00	100·00

Corresponding to the formula $I_6P_3O_8$. On one occasion this body was also observed in the residue from the preparation of fuming hydriodic acid; it was extracted, purified, and the analysis made as above described, yielding the following:—

I	81·91	81·88
P	8·36	8·22
O	9·73	9·90
	100·00	100·00

Corresponding to I_2PO_2, or, for better comparison with the above, $I_8P_4O_8$.

As it was considered not improbable that hydrogen might enter into its composition, a combustion was made, the substance being introduced in a boat before which was laid copper oxide, a long layer of lead chromate, and a silver spiral, but the amount found was too minute to be regarded.

I would mention here that in the preparation of methyl iodide the same body is apparently formed; but on attempting to purify in the same manner, a brown residue remained on treating with water. This was filtered off, and on evaporating the filtrate the crystals before noticed were not formed, but yellow flocks resembling freshly precipitated arsenic sulphide separated, which behaved very differently from that previously obtained.

An attempt to prepare this compound was made by leading phosphine gas, evolved by the action of water upon phosphonium iodide, into a solution of iodine in hydriodic acid, but so far without success. Owing to the very small quantities at disposal, and the want of a method of preparation, its more exact constitution cannot be given. As at present no definite formula seems to be indicated, any speculations as to the nature of this body, or whether possibly two or more exist, are premature.

Its further study will be continued at the earliest opportunity.—*American Chemical Journal.*

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.*

By JOSIAH PARSONS COCKE, Director.

(Concluded from p. 257.)

VI. REVISION OF THE ATOMIC WEIGHT OF CADMIUM.

By OLIVER W. HUNTINGTON, *of the Senior Class.*

The method adopted by Professor Cooke for verifying the value of the atomic weight of antimony, described previously, proved to be so definite and conclusive, that it seemed desirable to apply it in all other cases to which it was suited, in order not only to verify the received values of the atomic weights, but also to test more fully the hypothesis of Prout, an hypothesis to which recent investigation and speculations have given renewed interest.†

The method of Professor Cooke is applicable to all those elements of which a pure, stable, well-defined, and soluble bromide can be prepared. It consists in determining in one series of analyses the bromine of the compound as bromide of silver by the usual gravimetric method with the precautions already described; and in another series of experiments, or in the same analyses, when practicable, determining the amount of silver required to precipitate the bromine. We thus obtain not only the relation of the atomic weight sought both to that of bromine and to that of silver, but also the relation between the atomic weight of bromine and that of silver; and since all experimenters agree on this last ratio to within one ten-thousandth of its value it is evident that the comparison of the two series of results gives a sharp control of the accuracy of the work.

Professor Cooke assigned to me the atomic weight of cadmium as my portion of the work he had planned on the revision of the atomic weights, and this investigation was made with his aid and under his immediate direction. Bromide of cadmium fulfils all the conditions which the new method requires; and, since the accepted value of the atomic weight of cadmium is a whole number, it seemed probable that a revision of this value by a more exact process would bring additional evidence in support of the hypothesis of Prout.

Having found that bromide of cadmium could not readily be purified by repeated crystallisations on account of its very great solubility in water, we sought to obtain a pure

* Presented to the American Academy of Arts and Sciences, May 11, 1881.

† See Revision of the Atomic Weight of Aluminum, by J. W. Mallet, *Philosophical Transactions*, part iii., 1880: also various papers by J. Norman Lockyer on the disassociation of the chemical elements in *Nature* and in the *Proceedings of Royal Society*; also Cooke's "Chemical Phi osophy," revised edition, page 272.

compound by preparing pure carbonate of cadmium on the one hand and pure hydrobromic acid on the other.

To prepare pure carbonate of cadmium the commercial metal was first dissolved in pure hydrochloric acid. From this solution, still strongly acid, sulphide of cadmium was precipitated by sulphide of hydrogen and the precipitate thoroughly washed with hot distilled water. The sulphide having been re-dissolved in hydrochloric acid, and the resulting sulphide of hydrogen expelled by boiling, the cadmium was next precipitated as carbonate by carbonate of ammonia, and the precipitate digested with a large excess of this reagent. The white carbonate thus obtained was thoroughly washed and re-dissolved in hydrochloric acid, and the same series of precipitations repeated. Lastly, in order to remove any possible trace of adhering chloride, the carbonate of cadmium which had thus been twice precipitated by carbonate of ammonia, and twice digested with a large excess of this reagent, was dissolved in pure hydrobromic acid, and a third time precipitated and digested with pure carbonate of ammonia.

The hydrobromic acid used in this investigation was made by the process described by Dr. Edward R. Squibb, of Brooklyn, in the *Transactions of the Medical Society of the State of New York*.* In order to purify the acid, it was repeatedly re-distilled with a small amount of a concentrated solution of bromide of potassium, rejecting each time the distillate until the boiling-point rose to 128°; when, as is well known, an acid containing about 47 per cent of HBr distils unchanged. The acid thus obtained was as colourless as water.

Meanwhile, in order to test the purity of the hydrobromic acid and also as a basis for the rest of our investigation, we prepared a quantity of pure silver by the method already fully described, and with the pure silver thus prepared the following two setsof determinations were made.

For the first set, weighed amounts of silver were dissolved in very carefully purified nitric acid, using only a very slight excess of this solvent in any case. We prepared for the purpose a dilute acid by mixing one part of acid, having sp. gr. 1·355, with four parts of water and of this weak acid 5·3 c.m.³ were required for each gramme of silver. We were thus able to estimate the amount necessary for each analysis, and we used generally one half a cubic centimetre in excess.

The silver having been perfectly dissolved, and the solution diluted with water to from 200 to 500 cubic centimeters according to the amount of silver used, we gradually and cautiously precipitated bromide of silver by adding pure hydrobromic acid, prepared as just described, but greatly diluted until the acid was very slightly in excess. For the method of washing and collecting this precipitate, we may refer to vol. xii. page 124, of the *Proceedings of the American Academy of Arts and Sciences*.

The results were as follows:—

	Weight of Silver.	Weight of Bromide of Silver.	Per Cent of Silver.
1.	1·4852 grms.	2·5855 grms.	57·444
2.	1·4080 ,,	2·4510 ,,	57·446
3.	1·4449 ,,	2·5150 ,,	57·451
	Mean value		57·447

* "The formula and process for making an acid of this strength are as follows:—

Take of potassium bromide .. .. 6 parts
Sulphuric acid, sp. gr. at 15·6° C. 1·838, at 25° C. 1·828 .. 7 parts
Water .. .. 9 parts

"Add to the sulphuric acid one part of the water and cool the mixture. Then dissolve the potassium bromide in six parts of the water by means of heat, supplying the loss of water by evaporation during the heating. Pour the diluted sulphuric acid slowly into the hot solution with constant stirring, and set the mixture aside for twenty-four hours, that the sulphate of potassium may crystallise. Pour off the liquid into a retort, break up the crystalline mass, transfer it to a funnel, and, having drained the crystals, drop slowly upon them two parts of the water so as to displace and wash out the acid liquid. Add the liquid, thus drained off and washed out, to that in the retort, and distil the whole nearly to dryness, or until nothing further distils off by moderate heating. The distillate will weigh about ten parts and should contain about thirty-seven per cent of hydrobromic acid.

For the second set of experiments bromide of silver, precipitated, washed, and dried as described (*loc. cit.*), was melted in a platinum crucible, and then reduced by a voltaic battery under dilute sulphuric acid. This process was devised and perfected by Mr. L. P. Kinnicutt, Assistant in this Laboratory, who had the great kindness to conduct the reduction in the following determinations:—

	Weight of Bromide of Silver.	Weight of Silver.	Per cent of Silver.
1.	4·1450 grms.	2·3817 grms.	57·444
2.	1·8172 ,,	1·0437 ,,	57·434
3.	4·9601 ,,	2·8497 ,,	57·449
		Mean value	57·442

These results show conclusively the great accuracy of Mr. Kinnicutt's process, which he will describe in detail in another place. The mean of the two sets of results gives for the per cent of silver 57·445, the theoretical per cent (Ag=108 and Br=80) being 57·446. If we throw out No. 2 of second series, which is obviously less trustworthy than the other two determinations of the same series, on account of the comparatively small amount of material used, the mean of the remaining five determinations corresponds absolutely to theory, and the total result, therefore, leaves no doubt whatever, as to the absolute purity of the materials employed.

Bromide of cadmium was now prepared by dissolving pure carbonate of cadmium in pure hydrobromic acid, and subliming the product previously dried at 200° in a current of pure and perfectly dry carbonic dioxide gas. The carbonic dioxide was prepared by mixing bicarbonate of soda and sulphuric acid with a large volume of water in a strong generator, and drawing off the gas under pressure through appropriate washers and driers; and the apparatus used for subliming the bromide of calcium was similar to that described in the *Proceedings of the American Academy of Arts and Sciences* (vol. xiii., p. 57), using, however, a porcelain tube heated by a gas furnace in place of a tube of glass. The bromide of cadmium when thus sublimed crystallises in pearly scales around the open mouth of the tube.

Prepared as we have described, anhydrous bromide of cadmium is a splendid preparation. The precise form of the highly lustrous crystals could not be distinguished, but the scales are tabular crystals having a single optical axis normal to the extended face of the scales, and having a high negative double refracting power. Although so soluble, the crystals are not sensibly hygroscopic, and can be weighed on an open watch-glass without the slightest variation of weight during the process. They dissolve at once in water without leaving a trace of residue.

The following determinations were all made with the material we have described, and since only a few grains could be sublimed at a time the separate analyses were made with the products of nearly as many sublimations. Some of the material was sublimed twice, and the constancy of the composition under these circumstances is the best proof possible of the definiteness of the compound. The results of the analyses may be classed under two heads.

In one series of determinations the bromide of antimony, whose weight had been accurately determined, having been dissolved in pure water in a stoppered flask, a little less than the calculated amount of silver required to precipitate the bromide was carefully weighed out and dissolved in a measured amount of weak nitric acid, allowing, as before described, a slight excess. This solution properly diluted was then gradually added to the solution of bromide of cadmium under constant agitation, in order to avoid the aggregation of the bromide of silver in lumps. The agitation was frequently renewed until the precipitate settled, and then a standard solution of silver (1 grm. to the litre) was cautiously added until the precipitation was complete, and the last drops did not produce the faintest opalescence after standing. The precipitate was now

washed by decantation five times successively, using each time a volume of cold distilled water equal to the volume of the original solution, and pouring off the water into a porcelain crucible, from which it was drawn by the reverse filter. Finally, the precipitate was washed into the crucible, and, after drying at from 120° to 130°, weighed with the small filter.

In a second series the determinations were conducted in the same way as in the first, excepting that the chief attention was directed to determining the exact point of complete precipitation. In several cases, indicated by an asterisk, both the amount of silver required and the amount of argentic bromide formed were determined in the same experiment; but this was not always practicable.

First Series.

	Weight of Bromide of Cadmium.	Weight of Bromide of Silver found.	Value of Cd when Ag=108 and Br=80.
1.	1·5592 grms.	2·1529 grms.	112·32
2.*	3·7456 ,,	5·1724 ,,	112·28
3.	2·4267 ,,	3·3511 ,,	112·28
4.*	3·6645 ,,	5·0590 ,,	112·36
5.*	3·7679 ,,	5·2016 ,,	112·36
6.	2·7938 ,,	3·8583 ,,	112·27
7.*	1·9225 ,,	2·6552 ,,	112 26
8.	3·4473 ,,	4·7593 ,,	112·34
	Mean value		112·31

Second Series.

	Weight of Bromide of Cadmium.	Weight of Silver required.	Value of Cd when Ag=108 and Br=80.
1.*	3·7456 grms.	2·9715 grms.	112·27
2.	5·0270 ,,	3·9874 ,,	112·30
3.*	3·6645 ,,	2·9073 ,,	112·26
4.*	3·7679 ,,	2·9888 ,,	112·30
5.*	1·9225 ,,	1·5248 ,,	112·33
6.	2·9101 ,,	2·3079 ,,	112·35
7.	3·6510 ,,	2·8951 ,,	112·39
8.	3·9782 ,,	3·1551 ,,	112·35
	Mean value		112·32

As can easily be calculated according to the mean of the first series of determinations, 1·0000 grm. of bromide of cadmium gives 1·3808 grms. of argentic bromide, and according to the mean of the second series 1·0000 grm. of bromide of cadmium requires for complete precipitation 0·7932 grm. of silver. Hence, as a mean of these experiments, 0·7932 grm. of silver yields 1·3808 grms. of argentic bromide, and therefore corresponds to 0·5876 grm. of bromine. Moreover, since—

0·7932 : 0·5876 = 108·000 : 80·006,

it follows, with a very high degree of probability, that—

Ag : Br : Cd = 108·00 : 80·00 : 112·31,

within one ten-thousandth of the value of either quantity. It must of course be regarded as absolutely proved that, in the material analysed, the proportion of bromine to the remainder of the mass, assumed to be pure cadmium, is as 2 × 80·00 to 112·31, but it is always conceivable that the material used contained some unknown impurity. In the present case, however, such an assumption is highly improbable; first, because such extreme care was taken in the preparation; secondly, because the products of the different sublimations were so constant in composition; and, thirdly, because the presence of any of the metals usually associated with cadmium would tend to lower and not to raise the apparent atomic weight. If any impurity is present it would seem as if it must be some unknown element; and only on such a bare chance as this can the evidence be invalidated which the results of this investigation furnish against the hypothesis of Prout.—*Proceedings of the American Academy of Arts and Sciences.*

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

Saturday, November 26th, 1881.

Prof. W. G. Adams in the Chair.

Mr. C. Vernon Boys read a paper on "*Integrating Apparatus.*" After referring to his original "cart" machine for integrating, described at a former meeting of the Society, he showed how he had been led to construct the new machine exhibited, in which a cylinder is caused to reciprocate longitudinally in contact with a disk, and give the integral by its rotation. Integrators were of three kinds—(1) radius machines; (2) cosine machines; (3) tangent machines. Sliding friction and inertia render the first two kinds unsuitable where there are delicate forces or rapid variation in the barometer to be integrated. Tangent machines depend on pure rolling, and the inertia and friction is inappreciable. They are therefore more practical than the other sort. It is to this class that Mr. Boys's machines belong. The author then described a theoretical tangent integrator depending on the mutual rolling of two smoke rings, and showed how the steering of a bicycle or wheelbarrow could be applied to integrate directly with a cylinder either the quotient or product of two functions. If the tangent wheel is turned through a right angle at starting, the machine will integrate a reciprocals or it can be made to integrate functions by an inverse process. If instead of a cylinder some other surface of evolution is employed as an integrating surface, then special integrations can be effected. He showed a polar planimeter in which the integrating surface is a sphere. A special use of these integrators is for finding the total work done by a fluid pressure reciprocating engine. The difference of pressure on the two sides of the piston determines the tangent of the inclination of the tangent wheel which runs on the integrating cylinder, while the motion of the latter is made to keep time with that of the piston. In this case the number of revolutions of the cylinder measures the total amount of work done by the engine. The disk cylinder integrator may also be applied to find the total amount of work transmitted by shafting or belting from one part of a factory to another. An electric current meter may be made by giving inclination to the disk, which is for this purpose made exceedingly small and delicate, by means of a heavy magnetic needle deflected by the current. This, like Edison's, is a direction meter; but a meter in which no regard is paid to the direction of the current can be made by help of an iron armature of such a shape that the force with which it is attracted to fill the space between the poles of an electro-magnet is inversely as its displacement. Then by resisting this motion by a spring or pendulum the movement is proportional to the current, and a tangent wheel actuated by this movement causes the reciprocating cylinder on which it runs to integrate the current strength. Mr. Boys exhibited two such electric energy meters, that is, machines which integrate the product of the current strength by the difference of potential between two points with respect to time. In these the main current is made to pass through a pair of concentric solenoids, and in the annular space between these is hung a solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "induction traps" of iron, the magnetic force is confined to a small portion of the suspended solenoid, and by this means the force is independent of the position. The solenoid is hung to one end of a beam, and its motion is resisted by a pendulum weight, by which the energy meters may be regulated like clocks to give standard measure. The beam carries the tangent wheels, and the rotation of the cylinder gives the energy expanded in foot-pounds or other measures. The use of an equal number of turns in opposite directions on the movable

solenoid causes the instrument to be uninfluenced by external magnetic forces. Mr. Boys showed on the screen an image of an electric arc, and by its side was a spot of light, whose position indicated the energy, and showed every flicker of the light and fluctuation of current in the arc. He showed on the screen that if the poles are brought too near the energy expended is less, though the current is stronger, and that if the poles are too far apart, though the electromotive force is greater the energy is less; so that the apparatus may be made to find the distance at which the greatest energy, and so the greatest heat and light, may be produced.

At the conclusion of the paper, Prof. W. G. Adams and Prof. G. C. Foster could not refrain from expressing their high admiration of the ingenious and able manner in which Mr. Boys had developed the subject.

AMERICAN CHEMICAL SOCIETY.*

November 4, 1881.

Dr. Albert R. Leeds in the Chair.

The minutes of previous meeting were read and approved, after which the following gentlemen were elected as active Members:—Dr. C. W. Volney, Prof. R. A. Witthaus, C. E. Munsell, Nelson H. Darton, W. W. Share, and T. D. O'Connor.

As there were no new members to nominate, the next in order was the report from the Nominating Committee. This had to be deferred, however (as Dr. Endemann, the Chairman of said Committee, was absent), till Dr. Geyer and Mr. Casamajor had made out a list of candidates.

The Recording Secretary then announced the resignation of Prof. W. W. Wiley, which was duly accepted. After which the Recording Secretary read the death of Mr. Chas. Schmick, who died of pneumonia in March, 1881. It was then moved that Mr. Schmick's death be entered on the minutes. Carried unanimously.

The first paper of the evening, "*On some New Salts of Alpha-thymol-sulpho-acid, and some New Facts concerning the same*," by James H. Stebbins, jun., S.B., was then read. Mr. Stebbins in the course of his lecture described the calcium, ammonium, and soda salts of alpha-thymol-sulpho-acid, and likewise the free sulpho-acid, which was obtained by decomposing the lead salt with sulphuretted hydrogen. The calcium salt shows a beautiful effect of circular polarised light.

After some questions by Mr. Elliott, the second paper of the evening, "*On the Combination of Diazo compounds with Alpha-thymol-sulpho-acid*," by James H. Stebbins, jun., S.B., then followed. The following compounds were described:— Azo-benzol-alpha-thymol-sulpho-acid,

$$C_6H_5-N=N-C_6H(CH_3)(C_3H_7)(HSO_3)OH,$$

produced by the action of diazo-benzol chloride on an alkaline solution of alpha-thymol-sulpho-acid. Para-azo-toluol-alpha-thymol-sulpho-acid,—

$$C_6H_4(\overset{4}{CH_3})-N=N-\overset{1}{a}C_6H(CH_3)(C_3H_7)(HSO_3)OH,$$

produced by the action of para-diazo-toluol-chloride upon an alkaline solution thymol-sulpho-acid. Azoxylol-alpha-thymol-sulpho-acid,—

$$C_6H_3(CH_3)_2-N=N-aC_6H(CH_3)(C_3H_7)(HSO_3)OH,$$

produced by the action of diazo-xylol chloride upon an alkaline solution of alpha-thymol-sulpho-acid.

After some questions by Messrs. Elliot and Friedburg, the third paper, "*On the Constitution of the Explosive Derivatives of Glycerin*," by Dr. Volney, was then read. Some questions by Dr. Friedburg and others then followed.

The report of the Nominating Committee was now ready, and the following gentlemen were duly nominated for the coming elections:—For Corresponding Secretary—Mr. P. Casamajor. For Treasurer—M. Alsberg. Recording Secretary—James H. Stebbins, jun. Librarian—Dr. E. Waller. For Curators—Messrs. Rossi, Fesquet, and Rupp. For Committee on Nominations—Arthur H. Elliott, J. F. Battershall, O. H. Krause, Mr. Herreshoff, and T. O'C. Sloane. Committee on Papers and Publications—Arno Behr, A. R. Ledoux, H. Endemann. As Directors—P. Casamajor, James H. Stebbins, jun., H. Morton, C. F. Chandler, M. Alsberg, E. R. Squibb, W. H. Nichols, W. M. Habirshaw, Elwyn Waller, H. Endemann, August Eimer, Geo. Prochazka.

The meeting then adjourned.

* Communicated by James H. Stebbins, jun., Recording Secretary.

NOTICES OF BOOKS.

Elementary Treatise on Physics, Experimental and Applied, for the Use of Colleges and Schools. Translated and edited from Ganot's "Eléments de Physique," by E. Atkinson, Ph.D., F.C.S., Professor of Experimental Science, Staff College, Sandhurst. Tenth edition, revised and enlarged. London: Longmans and Co.

When a book like this has already reached its tenth edition it may well claim to be beyond the scope of criticism, as having won the approval of such competent judges as the professors of experimental science in our leading colleges. Nor can our readers expect much to be said by way of description of a work so well known. The various branches of physics are here arranged in the following order:—The phenomena depending upon gravitation,—included by some methodologists under the name "barology," and by others as dynamics, but here not included under any general head,—acoustics, heat, light, magnetism, and electricity. This classification agrees with that of Comte, save that the latter intercalates acoustics between thermics and optics—an arrangement not in harmony with his law of decreasing generality.

The present edition contains a considerable amount of additional matter descriptive of recent discoveries, and may be pronounced fairly on a level with the present state of science. A few points may be noticed in which the editor has adhered too closely to the French original. Thus we regret to see the term "Daltonism" retained as a name for colour blindness. It is offensive, inexpressive, and utterly needless. In speaking of hydrometers, that of Beaumé is described in place of the direct specific gravity instrument, or of Twaddle, both of which are not merely much more generally used in England, but are admitted to be more rational by foreign technologists, such as the late Prof. Bolley.

It might also have been well, in speaking of the lactometer, to have shown that the reason of its worthlessness lies not so much in the varying density of milk in its natural state, as that the abstraction of the cream raises the specific gravity, which can then be restored to its original standard by admixture with water.

The experimental results of MM. Cailletet and Pictet are duly noticed, and though "permanent gases" are mentioned in the index, a reference to the text shows that no such class of bodies exists.

The account of recent improvements in the electric light is perhaps as complete as the quantity of space at the editor's disposal would allow. The Jablochkoff "candle" and the Werdermann and the Regnier lamps are described, though we have no mention of the Swan, the Siemens, or the Brush systems.

The work is admirably illustrated with 844 woodcuts and 4 coloured plates; the table of contents and the index are accurate and copious, and we have not observed any typographical errors. The present edition well deserves an increase of the approval which has been awarded to its predecessors.

An Elementary Treatise on Electricity. By James Clerk Maxwell, F.R.S. Edited by W. Garnett, M.A. Oxford: Clarendon Press. London: H. Frowde.

We have here a posthumous work by one who was not merely an eminent and successful physicist, but a profound and philosophic thinker, careful to draw no unwarranted conclusions from phenomena, and soundly critical in methods either for ascertaining new truths or for displaying those already established in their organic connection. It appears from the editor's preface that eight of the thirteen chapters of the present work were found in a complete condition. Chapters IX. and X. were nearly perfect, though some references, tables, and a small part of the text were still wanting. The remaining three chapters have been completed by the introduction of matter from Professor Maxwell's earlier and larger work, "Electricity and Magnetism," the continuity of the whole being preserved as well as possible. The fragmentary portion of the author's preface which has been discovered is important as showing the point of view of the present volume. He tells us that its aim is different from that of his larger treatise on electricity and magnetism. In that treatise the reader is assumed to be familiar with the resources of the higher mathematics, and the course of study laid down is calculated to give him the power of dealing mathematically with the various phenomena of the science. In the work before us such methods are not employed; the author has sought to present concisely and compactly such phenomena as appear to throw light on the theory of electricity, using them successively for the development of clear ideas in the reader's mind. There is a further difference between the two works. In the earlier the author has employed certain methods, not as being in themselves the best, but as necessary for the student if he is to follow the investigations of those physicists who have founded the mathematical theory of electricity. Professor Maxwell subsequently became more convinced of the superiority of the class of methods used by Faraday, and has therefore used them from the outset.

The first chapter opens with experiments showing electrification by friction, the electrification of a conductor, positive and negative electrification, the nature and use of Volta's electrophorus and of the gold-leaf electroscope. By means of these experiments the author is able to explain electromotive force, which is defined as whatever produces or tends to produce a transfer of electrification; the meaning of the term potential, which he defines thus:—Electromotive force from any point along a path drawn in air to a certain point chosen as a point of reference is called the potential at that point. We find here a useful caution against a common and misleading expression:—"We may introduce once for all the common phrase *The Electric Fluid* for the purpose of warning our readers against it. It is one of those phrases which, having been at one time used to denote an observed fact, was immediately taken up by the public to connote a whole system of imaginary knowledge. As long as we do not know whether positive or negative electricity, or both, should be called a substance or the absence of a substance, and as long as we do not know whether the velocity of an electric current is to be measured by hundreds of thousands of miles in a second or by an hundredth of an inch in an hour, or even whether the current flows from positive to negative, or in the reverse direction, we must avoid speaking of the electric fluid." We find here also an explanation of equipotential surfaces, and a further illustration of the idea of electric potential by comparison with pressure in the theory of fluids and with temperature in the theory of heat.

In the second chapter we find further experiment on an electrified body within a closed vessel; on the comparison of the charges or total electrification of two electrified balls, proving the electrification of the inside of a closed vessel equal and opposite to that of the enclosed body, and showing how to discharge a body completely and to charge with any given multiple of a particular charge. In this manner the author displays electric charge as a quantity capable of being measured, and demonstrates five of the principal laws of electric phenomena.

The third chapter is composed of deductions from these facts, treating on electric work and energy. Those readers who have not some acquaintance with elementary mathematics may, according to the author's recommendation, omit this chapter in their first perusal of the work.

The fourth chapter is devoted to the electric field and the methods for its electrification. In the following chapters the author treats successively of Faraday's law of lines of induction, of particular cases of electrification, of electrical images, capacity, the electric current in metals, electrolysis, and dielectrics, the phenomena of an electric current which flows through heterogeneous media, the maintenance of an electric current, the measurement of electric resistance, and on the electric resistance of substance.

For the student who wishes to obtain a really sound knowledge of electricity we say emphatically, this is the book. We may add that even the accomplished physicist, who is already acquainted with every fact here described, and with every law laid down, cannot fail to find here an intellectual treat of no mean order. It is a pleasure to see how clearly the phenomena are described and arranged, and how happily they are made to establish the generalisations of the science.

Manchester Mechanics' Institution. Syllabus of Classes, 1881-82. Manchester: A. Ireland and Co.

The Manchester Mechanics' Institution is, we believe, one of the most efficient and successful establishments of its class. It has more distinctly than many kept in view the original object expressed in the first paragraph of this pamphlet, viz., "To instruct the people in the principles of the Arts they practise, and in other branches of sound and useful science and learning," and now offers very great facilities to students. Turning naturally to the Science Department, we find that there are special classes for sound, light, and heat, for electricity and magnetism, in both which the text-book for the more advanced grade is Deschanel's "Natural Philosophy"; for inorganic and organic chemistry; for geology, mineralogy, and metallurgy. There are also technical classes for the subjects of telegraphy and telephony, photography, and a school of dyeing conducted by Mr. C. O'Neill, whose introductory lecture we notice elsewhere.

Introductory Lecture to a Course of Technical Instruction in Dyeing, Calico-printing, and Bleaching. By C. O'Neill, F.C.S. Manchester: John Heywood.

It appears that in connection with the Manchester Mechanics' Institution a laboratory for instruction in the tinctorial arts has been opened. In the introductory lecture before us, which appears to have been delivered a year ago, Mr. O'Neill does not take a very sanguine view of the benefits to be derived from technological instruction, or even the need of it, in this country. The dyers, &c., of Manchester it seems are less thoroughly convinced than their neighbours in Leeds and Bradford that we have any room for improvement. We read here—"When a manufacturer is shown something in dyed work or in prints superior to his own productions, he will most usually say that he could do that if it suited him to do it, but he prefers to stick to what he is doing and leave to others the fancier styles. This reminds us of the assertion of a certain poet of low degree that he could write as well as Shakespeare if he had a mind. Does it not seem as if our sticking to inferior work—to the "cheap and nasty" styles—was not quite a matter of choice on our part? Was it not declared by independent judges, *e.g.*, that at the last Paris Exhibition certain alizarin-red grounds produced in Russia were superior in brightness to anything of English origin?

Again—"I never heard from manufacturers the complaint that they suffered from an inferiority of technical knowledge either in themselves or in their employees." Now it is well known that a man in any business or art is generally the very last to perceive his own shortcomings. These are generally detected by others. But admitting for argument's sake that the Polytechnic Schools of Germany, Switzerland, &c., have not succeeded in raising the manufacturers and foremen of those countries to a position superior to our own, is that any reason that we should rest on our oars and leave improvement to accident or to the desultory action of individuals? But we certainly should have thought that by this time the progress made on the Continent would have startled the most self-complacent disciple of rule-of-thumb from his dreams, and silenced his sneers against "theorists." It seems we were mistaken, and we own it with sorrow.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 18, October 31, 1881.

This issue contains no chemical or physical matter.

No. 19, November 7, 1881.

Limits of Electrolysis.—M. Berthelot.—It is known that the researches of Joule and Favre have established relations between the electro-motor forces and the combining-heats of the metals, but the application of these laws to the electrolysis of salts is often very obscure, especially when secondary actions are produced and it is required to know the exact sum of all the energies which concur in the electrolytic phenomenon. Physicists admit at present that the electrolysis of potassium sulphate takes place in the same manner as that of copper sulphate. The metal goes to the negative pole, and the sulphuric acid to the positive. If the metal does not decompose water, it is precipitated on the electrode; otherwise it is replaced by hydrogen, as happens with potassium sulphate. The electro-motor force necessary to produce the electrolysis may be calculated in three different manners, which the author gives in detail, and the last of which agrees with his experimental results.

Combustions effected by Nitrogen Binoxide.—M. Berthelot.—An important thermo-chemical paper, not suitable for abridment.

Synthetic Experiments on the Artificial Reproduction of Meteorites.—F. Fouqué and Michel Lévy.—By means of igneous fusion the authors have succeeded in reproducing two types of crystalline associations, which, in their mineralogical composition and the principal features of their structure, are analogous if not identical with certain oligosideric meteorites. The only notable difference results from the habitual brecchoid state of the meteorites, which contrasts with state of quiet solidification of the artificial compounds.

Silica and Lithium Silicates.—P. Hautefeuille and J. Margottet.—The authors have obtained three crystalline lithium silicates—$SiO_2 2LiO$, $SiO_2 LiO$, and $5SiO_2 LiO$. The two former are acted on by acids, whilst the third resists the action of concentrated acids; they are almost as infusible as the magnesium silicates. At high temperatures they become very fluid and absorb much heat, which they evolve again at the moment of their solidification. Melted lithium chloride has enabled the authors to establish that silica may take the form of quartz in presence of a melted chloride.

The Yield and the Limit of the Operation of the Transfer of Power by means of Electricity.—M. Maurice Lévy.—Two purely mathematical papers, not capable of abstraction.

Possibility of Electric Equilibrium.—Lucien Lévy

Experimental Method for the Determination of the Ohm.—G. Lippmann.—This memoir requires the accompanying illustration.

The Action of Cold on the Voltaic Arc.—D. Tommasi.—When the voltaic arc plays between two metallic rheophores, of copper for instance, each formed of a U-tube traversed by a rapid current of cold water, and placed horizontally opposite each other, the following facts are observed:—The luminous power of the arc is considerably weakened; it is reduced to a mere luminous point even when a current of 50 to 75 Bunsen elements of the large pattern is employed. The arc is very unstable and the least breath is sufficient to distinguish it. If a leaf of paper is placed above the arc at the distance of 0·004 to 0·005 metre a black point is produced in a few moments, which spreads and becomes a perforation, but the paper does not ignite. The arc consists of a luminous globule, moving between the two rheophores up and down and back again. The form of this globule, as well as its extreme mobility, cause it to resemble a drop of water in the spheroidal state. If we approach to the voltaic arc the south pole of a magnet the arc is attracted to such a degree that it leaves the rheophores and is extinguished. The same facts are observed in an inverse form on presenting the north pole of a magnet to the arc. The quantity of ozone seems greater than when the arc is not refrigerated. It is to be noted that notwithstanding the refrigeration of the rheophores the flame of the arc is slightly green, proving that a portion of the copper is burning. It becomes a question whether the arc would be produced on taking as rheophores two tubes of platinum in which is caused to circulate, *e.g.*, alcohol cooled to $-30°$.

An Electric Method of Determining by means of a Needle the Position and the Depth of a Projectile or other Metallic Substance in the Human Body.—A. Graham Bell.—The substance of this communication is already well known.

Cuproso-cupric Sulphite.—A. Etard.—This double sulphite is obtained by passing a rapid current of sulphurous acid into a solution of cupric acetate saturated in the cold and kept at 65°. The passage of the gas is stopped when the liquid which was at first turbid becomes clear, and the salt in question is deposited as a crystallo-granular precipitate.

Hydrated Chromium Bromide.—M. Varenne.—The author obtains this compound, $Cr_2Br_3 + 16HO$, by submitting a hot and concentrated solution of potassium or ammonium trichromate to the action of dilute hydrobromic acid. The liquid, if left to stand at a temperature near 0°, deposits the new compound in fine violet crystals.

The Action of Hydracids upon the Alkaline Chromates.—L. Varenne.—An examination of the especial action of hydrofluoric acid upon the alkaline trichromates.

Reply to M. Debray's Observations on the Dissociation of Ammonium Hydrosulphate.—MM. Engel and Moitessier.—A question of priority.

Artificial Peridote produced in Presence of Watery Vapour at the Ordinary Pressure.—St. Meunier.—The author's method consists in exposing the metal to be silicated to the simultaneous action of a red heat, of steam, and of silicium chloride.

Modifications in the Composition of Green Forage Preserved in "Silos."—G. Lechartier.—There is a slight decrease in the percentage of nitrogenous matter, whilst an increase in ammonia shows an incipient decomposition of the albumenoids. There is a more considerable loss of glucosides and an increase of fatty matter.

Vapour Tensions of Ammonium Carbamate.—M. Isambert.—The law announced by MM. Engel and Moitessier (*Comptes Rendus*, xciii., p. 395) does not agree with the experimental results of the author.

Action of Hydriodic Acid upon Propylene Chloro-iodide and Isopropyl-chloride.—R. D. Silva.—The results of the reaction is isopropyl-iodide.

Justus Liebig's Annalen der Chemie,
Band 209, Heft 1.

Addition-Products of Atropic Acid.—G. Merling.—The author has obtained a β and an α hydrochloratropic acid. The former of these is obtained by the combination of atropic acid with hydrochloric acid, either at 100° or in the cold. It melts at 87° to 88°, and is decomposed at 170°. On boiling with an alkaline carbonate or with water it yields chiefly tropic acid along with small quantities of styrol and atropic acid. The α acid is formed by the action of hydrochloric acid upon atrolactic acid. It melts at 73° to 74°, decomposes at 110°, and yields no styrol when boiled with an alkaline carbonate. He has also obtained and described a β and an α hydrobrom-atropic acid and a β amido-hydratropic acid.

Diabetic Aceton-urea.—Dr. A. Beichmüller.—In a fatal case of diabetes, 40 litres of urine, giving a red reaction with ferric chloride, yielded 22·5 grms. of aceton, but no alcohol. Hence the red reaction is due not to acetester, but to free acetic acid.

Urine which is Coloured Red by Ferric Chloride.—B. Tollens.—The author has examined specimens of diabetic urine from the above described case, and comes to a similar conclusion.

Conchinamine.—A. C. Oudemans, jr.—The author describes the preparation of conchinamine and quinamine from the quinetum of Darjeeling; the properties and composition of conchinamine, its reactions, and specific rotatory power in solution in presence of different acids.

Conchinamine.—O. Hesse.—The author describes the properties of conchinamine, $C_{19}H_{24}N_2O_2$; its salts and optical behaviour.

Action of Zinc-methyl upon Chlorine Substitutes of Acetyl-chloride.—J. Bogomolez.—Not susceptible of useful abstraction.

Communications from the Laboratory of the University of Zurich.—This article consists of researches on benzol-quinon and certain of its derivatives by E. Sarow. The author examines the action of quinon on concentrated hydriodic, hydrobromic, and hydrochloric acids. He concludes that quinon and concentrated hydrochloric acid form, in the first place, quinhydron, which finally passes into mono-chlor-hydroquinon. With hydrobromic acid there is produced, first, quinhydron, then mono brom-hydroquinon along with dibrom-hydroquinon. Hydriodic acid converts quinon into hydroquinon. The bromised hydroquinons are easily formed by the reaction of different quantities of bromine upon hydroquinon. If the solutions of the bromised hydroquinons are treated with dehydrogenising agents, there are formed the corresponding bromised quinons. Upon concentrated hydrobromic acid the bromised quinons act as oxidising agents.

Ethers of Naphthalin.—C. Graebe.—This treatise consists of three papers, on α and β dinaphthylen-oxide, by W. Knecht and J. Unzeitig; on α and β naphthylen-phenylen-oxide, by J. von Arx; and on naphthyl-ether, by C. Graebe.

Naphthyl-phenyl-amin.—Jacob Streiff.—An examination of α and β naphthyl-phenyl-amin, and their compounds.

Band 209, Heft 2 and 3.

Communications from the University Laboratory at Graz.—These include a memoir by F. Pfeifer on the electrolysis of solutions of antimony chloride and on explosive antimony; a paper by K. Garzarolli-Thurnlackh, on the supposed chlorine trioxide; and an account of certain salts of chlorous acid, by K. Garzarolli-Thurnlackh and K. Freiherr von Hayn.

Communications from the Chemical Institute of the Royal School of Forestry of Aschaffenburg.—These communications refer to syntheses effected by means of malonic ester, and include papers by M. Conrad and C. A. Bischoff on nitroso-malonic ester and its derivatives; a memoir by the same authors on mono-chloro-malonic ester and tartronic acid; a paper by M. Guthzeit on ethyl- and isobutyl-chloro-malonic ester, ethyl- and isobutyl-tartronic acid, ethyl- and isobutyl-hydroxy-acetic acid; and an account of benzyl-chloro-malonic ester, benzyl-tartronic acid, and phenyl-lactic acid.

Galleine and Cœruleine.—Dr. K. Buchka.—In this very elaborate memoir the author treats, first, of galleine; secondly, of cœruleine; thirdly, of the derivatives of galleine springing from triphenyl-methan, such as tetra-acetyl-galleine, tetra-benzoyl-galleine, dibrom-galleine, tetra-acetyl-dibrom-galleine, hydro-galleine, galline, tetra-acetyl-galline, gallol, penta-acetyl-gallol, anhydro-pyro-gallol-keton, tetra-acetyl-anhydro-pyro-gallol-keton. In the fourth chapter he considers the derivatives of galleine which are traced to phenyl-anthracen, such as cœruleine, triacetyl-cœruleine, cœruline, tetra-acetyl-cœruline, and finally the conversion of cœruleine into phenyl-anthracen.

The Halogens.—Dr. H. Züblin.—A re-examination of the theory that the halogens are oxides of unknown radicles. Notwithstanding all attempts made in the most varied manners and under the most favourable conditions no facts were observed which could in any way support the assumption of the presence of oxygen in the halogens.

Isoheptylic Acid from β-Hexyl-iodide.—Otto Hecht.—This paper does not admit of useful abstraction.

Anhydro-Compounds.—H. Hübner.—In the several sections of this voluminous memoir we find an account of diphenyl, its derivatives, and its anhydro-base; of the paramido-diphenyl-compounds; the amidation of mono-nitro-benz-paramido-diphenyl; the iso-amido-diphenyl-compounds; the acetanhydro-compounds; trichloracetic acid and an ortho-diamide; and the anhydro-bases formed with bibasic acids.

Journal für Praktische Chemie.
Nos. 14 and 15, 1881.

Action of Chloride of Lime upon the Alcohols.—Dr. A. Goldberg.—In this memoir the author examines the action of chloride of lime upon ethylic alcohol in equivalent proportions. In a former volume (19, p. 393), the author describes the production of a greenish yellow oil, which on exposure to light or heat explodes, giving off chlorine, hypochlorous acid, and hydrochloric gas. He next describes the action of lime upon mono-chlor-acetal, upon alcohol in other proportions, upon dilute alcohol, upon chemically pure methylic alcohol, and iso-amylic alcohol.

Urethan.—W. Schmid.—By the action of chlorine upon urethan or ethyliden-urethan, the author obtains dichlor- and mono-chlor-ethyliden-urethan, almost in theoretical proportions.

Action of Sulphuric Acid upon Citric Acid and Resorcin.—Max Wittenberg.—By this reaction the author obtains a crystalline product, which he names resocyanin, $C_{21}H_{18}O_6$. It is almost insoluble in cold water, sparingly soluble in hot water and in ether, but readily soluble in alcohol. It is characterised by a beautiful blue fluorescence. In capillary tubes it melts at 185°. Its solutions are not coloured by ferric chloride.

Preparation of Sulphuryl Chloride: a Contribution to the Doctrine of Catalysis.—Hans Schulze.—An experimental inquiry into the fact that sulphurous acid united in a solution with camphor is capable of combining

with chlorine gas to form sulphuryl chloride. The author does not succeed in solving the problem. He feels inclined to seek the source of the almost unlimited activity of camphor and its consorts (the number of which will be doubtless considerably increased) not in purely chemical forces. It will more probably be found in mechanical causes, the nature of which can be merely conjectured.

Methods of and Researches in Physical Chemistry.—Otto Petterson.—The first portion of an extensive memoir, dealing chiefly with the liberation of heat and the change of volume in solid bodies when melting or when near their melting-points.

Anthology of Modern Chemical Utterances.—H. Kolbe.—The "flowers" are plucked from the writings of Wislicenus, Kekulé, &c.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., No. 92.

Action of Solar Light upon Glass.—Thomas Gaffield.—The translation of a paper read before the Chemical Section of the American Association for the Advancement of Science, Aug. 27, 1880.

Tome viii., No. 93.

Report on the Electric Counter (Gasmeter) of M. Demoulin-Froment, Presented by M. Serbert on behalf of the Committee of Economical Arts.—This paper requires the accompanying illustrations.

International Congress of Electricians.—Under this head are placed the speeches delivered by M. Dumas and by M. Mascart at the final session of the Congress.

Electric Measures.—M. Dumas.—This paper has been already noticed.

Modification of the Electric Lamp.—M. Jamin.—Taken from the *Comptes Rendus*.

The Magnesia Industry.—T. Schlœsing.—Taken from the *Comptes Rendus*.

Neutral Refined Oils.—A. Thiollier.—Oils for lubricating purposes should be neither oxidisable nor capable of oxidising other bodies. They should contain neither free fatty acids nor mucilage. An account is given of certain oils prepared by a M. Melizan, which are said to be free from both these constituents, but his process is not explained.

Annales de la Société des Sciences Industrielles de Lyon. No. 1, 1881.

These Annales still persist in avoiding the especial industries of Lyon.

Les Mondes, Revue Hebdomadaire des Sciences. No. 15, August 11, 1881.

Derivatives of Saligenine.—K. Bötsch.—A notice of the salicylic, ethylic, and methylic alcohols.

Compounds of the Pyrrol Series.—Dr. Ciamician.—The homo-pyrrol of animal oil is probably a mixture of two acids, the α- and β-carbo-pyrrolic.

Sulph-ortho-phenolic Acid.—Dr. Herzog.—The ortho-acid, on fusion with potash, yields pyro-catechine and a diphenol.

Ellagic Acid.—M. Cobenzyl.—The author obtains γ-hexa-diphenol on treating an alkaline solution of ellagic acid with sodium amalgam.

No. 16, August 18, 1881.

Passivity of Iron.—E. Roman.—The passivity of iron plunged into nitric acid is due to the formation of a layer of magnetic oxide on its surface.

Relation between the Magnetism of Bodies and their Atomic Weights.—L. Evrera.—The author has reached conclusions similar to those of Mr. Carnelley; he has experimented independently, and it is alleged at an earlier date.

No. 17, August 25, 1881.

This number contains no chemical matter not taken from other journals.

No. 18, September 1, 1881.

The Faure accumulator has been tried on a tramway-car of peculiar construction, but the exact result has not been made known.

Improvements in Magnets.—M. Trouvé.—The substance of this paper has been already extracted from the *Comptes Rendus*.

Bleaching of Silk and Wool by Liquid Sulphurous Acid.—Raoul Pictet.—In a paper read before the Faculty of Sciences at Geneva the author recommends sulphurous anhydride in place of the fumes of burning brimstone. Among the disadvantages of the latter he mentions the injury to the health of the workmen, and occasional damage to the cloth or yarns from volatilised particles of sulphur, which become attached to the fibre and occasion a burn, or at least a spot.

The Cyclides and the Encyclides in the Three Kingdoms of Nature.—Dr. Charles Brame.—The author traces numerical relations which approximate to the multiple proportions of chemistry.

No. 1, September 8, 1881.

Analysis of the Light of the Comet *b* of 1881.—M. Fievez.—A great portion of the light of the comet is inherent in it, whilst another part is reflected. The strong polarisation of the nucleus indicates a decided state of condensation. The spectrum of the comet differs little from that of others which have been examined.

Effects of Lightning upon Trees Planted near a Telegraph Wire.—C. Montigny.—The vicinity of a telegraph wire exposes objects not merely to the dangers of induction sparks, but to the direct stroke of the lightning.

The Electric Brake.—The writer describes an arrangement patented by A. Basin.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 5th.—Medical, 8.30.
—— Society of Arts, 8. "Some of the Industrial Uses of the Calcium Compounds," by Thos. Bolas, F.C.S.
—— London Institution, 5.
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 6th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 7th.—Society of Arts, 8. "The American System of Heating Towns by Steam," by Capt. Douglas Galton, C.B., F.R.S.
—— Geological, 8.
—— Pharmaceutical, 8.
—— Obstetrical, 8.
THURSDAY, 8th.—Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 9th.—Quekett Microscopical Club, 8.
—— Astronomical, 8.
SATURDAY, 10th.—Physical, 3.

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THE CHEMICAL NEWS.

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ON THE

CONSTANCY OF THIOSULPHATE SOLUTIONS.

By SPENCER UMFREVILLE PICKERING, B.A., Oxon.,
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In the course of some work in which standard solutions of sodium thiosulphate were in constant use, it became desirable to ascertain the circumstances under which solutions of this salt remained most constant. In order to accomplish this a number of solutions, both of sodium and of potassium thiosulphate, were prepared and subjected to different conditions, their titres being determined from time to time by comparison with a standard solution of potassium bichromate, or with weighed quantities of that salt.

The following method was usually adopted in the titration of the solutions:—A given volume of the standard bichromate solution was treated with definite quantities of potassium iodide and hydrochloric acid. A certain volume of the thiosulphate solution sufficient to be very nearly equivalent to the liberated iodine was then added, and the small quantity of iodine which still remained free was determined by a standard solution of thiosulphate, the strength of which had been previously ascertained. The various corrections for the acid added and for differences of temperature were made in accordance with the results of a previous research (*Journ. Chem. Soc.*, 1880, 128); the results given in the following tables being also reduced so as to be more easily comparable with each other: a difference of 0·012 c.c. in the tables corresponds to a difference of about 0·01 c.c. in the actual observations.

In some preliminary experiments an apparent increase in the strength of the thiosulphate solutions was noticed during the first few days, and, as this could only be explained by a corresponding decrease in the strength of the bichromate solution, a few experiments were made in order to ascertain whether a neutral solution of this latter salt would oxidise any organic matter which might happen to be present in it.

A standard solution of potassium bichromate was taken, and, after ascertaining that its strength was not altering at the time, a small quantity of dust was introduced and its strength again determined from time to time. The following results were obtained:—

Strength of the solution at first	100·00
" " after 1 day ..	100·02
" " " 2 days ..	99·89
" " " 3 " ..	100·15
" " " 4 " ..	99·99

Some dust was then introduced.

Strength of the solution after 1 day ..	99·68
" " " 3 days ..	99·79
" " " 6 " ..	99·76
" " " 52 " ..	99·56
" " " 362 " ..	99·28

Again, a solution of bichromate, to which some grape-sugar had been added, was found to have lost 11·52 per cent of its oxidising power in the course of eight months, a brown deposit of chromium hydrate being formed at the same time. Light, although not essential to the action, was found to accelerate it.

These experiments clearly show that any organic matter which might happen to be present in the water used for dissolving the bichromate would cause a diminution in the available strength of the solution.

TABLE I.—SODIUM THIOSULPHATE SOLUTIONS.

Time elapsed since making the Solutions.	SOLUTION A.—In White Bottle in Diffused Daylight.		SOLUTION B.—In Blue Bottle in Diffused Daylight.		SOLUTION C.—In Blue Bottle in the Dark.		SOLUTION D.—In Blue Bottle in Diff. Dylght. Traces KOH added.		SOLUTION E.—In Blue Bottle in Diff. Dylght. Amm. Carb. added.	
	C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphide.	C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.
nil	14·66 14·66	100·0	14·66 14·66	100·0	14·66 14·66	100·0	14·66 14·66	100·0	14·648 14·672	100·0
	14·612									
2 days	14·618 14·618	99·7								
5 days	14·587 14·587	99·5	14·635 14·640	99·85	14·659 14·659	99·9	14·625 14·625	99·76	14·654 14·606	99·80
17 days	14·564 14·612	99·51	14·588 14·640	99·55	14·616 14·616	99·7	14·607 14·595	99·6	14·608 14·572	99·52
60 days	14·549 14·549	99·24	14·548 14·560	99·28	14·589 14·601	99·56	14·616	99·7	14·484	98·8
92 days	14·563 14·551	99·3	14·563 14·551	99·30	14·594 14·582 14·570	99·47	14·580 14·568	99·41	14·443 14·419	98·44
99 days									14·404	
181 days	14·513 14·513	99·0	14·521 14·521	99·05	14·554 14·554	99·28	14·546 14·534	99·18	14·380 14·392	98·17
365 days	14·443 14·443	98·6	14·465 14·474	98·75	14·505 14·505	98·94	14·484 14·494	98·84	14·270 14·234 14·166 14·142	97·24 95·95

TABLE II.—Sodium Thiosulphate Solutions.

Time elapsed since making the Solutions.	Solution J.—In White Bottle in Diffused Daylight. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	Solution K.—In Blue Bottle in Diffused Daylight. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	Solution L.—In Blue Bottle in Diffused Daylight. KOH added. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	Solution H.—In Blue Bottle in Strong Daylight and Sunlight. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.
nil	13·904 13·898 13·898 } 13·90	100·0	13·904 13 898 13·898 } 13·90	100·0	14·00 14·00 } 14·00	100·0	7·016 7·004 7·016 } 7·012	100·0
1 day	13·881 13·893 } 13·887	99·91	13·89 13·89 } 13·89	99·84	13·991 13·994 14·009 14·009 } 13·997	99·98		
2 days	13·878	99·84	13·883 13·847 } 13·865	99·75	13·984 14·008 } 13·996	99·97		
3 days	13·852 13·864 } 13·858	99·7	13·847	99·62	13·975 14·011 } 13·993	99·95		
5 days	13·864	99·74	13·872	99·8	13·980	99·86		
6 days							6·994 6·994 7·010 6·994 } 6·998	99·8
10 days	13·855 13·843 } 13·849	99·63	13·870 13·846 } 13·858	99·7				
43 days							6·942 6·942 6·930 6·930 } 6·936	98·92
71 days							6·915 6·915 6·903 } 6·911	98·56
86 days	13·815 13·839 13 830 } 13·828	99·46	13·844 13·844 } 13·844	99·6				
365 days	13·552 13·552 } 13·552	97·5	13·647 13 635 } 13 641	98·14				
421 days							6·486 6·474 6·474 } 6·478	92·37

TABLE III.—Potassium Thiosulphate Solutions.

Time elapsed since making the Solutions.	Solution F.—In Blue Bottle in Diffused Daylight. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	Solution G.—In White Bottle in Diffused Daylight. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.	Solution I.—In Blue Bottle in Diffused Daylight. Bottle often opened. C.c. of Bichromate required for 10 c.c. of the Thiosulphate.	Strength of the Thiosulphate.
nil	13·010 13·022 13·998 } 13·01	100·0	13·010 13·022 12·998 } 13·01	100·0	14·712 14·712 14·712 } 14·712	100·0
5 days	12·978 12·290 } 12·989	99·8	12·996 12·984 } 12·99	99·85		
17 days	12·981 12·981 12·934 } 12 965	99·5	12·963 12·963 } 12·963	99·64	14·663 14·663 } 14·633	99·46
60 days	12·906 12·906 } 12·906	99·2	12·899	99·15	14·609 14·597 } 14·603	99·26
92 days	12·902 12·866 } 12·884	99·02	12·902 12·866 } 12·884	99·03	14·600 14·588 } 14·594	99·2
181 days	12·822 12·834 } 12·828	98·6	12·823 12·811 } 12·817	98·52	14·549 14·537 } 14·543	98·85
365 days	12·789 12·753 } 12·771	98·16	12·667 12·643 } 12·655	98·04	14·531 14·525 } 14·528	98·75
458 days					14·136 14·124 14·112 } 14·124	96·0

The bichromate solution used in the following experiments was one which had been made for some time, and in which no change whatever took place throughout the whole duration of the experiments, a fact which was ascertained by direct determinations made from time to time.

In the experiments given in Table I. all the solutions were approximately decinormal in strength, containing 0·019163 grm. of $Na_2S_2O_3$ per c.c. The experiments, extending over a year, were begun in the latter end of December. At the beginning the bottles were about three-quarters full of the solution, while at the end they were about half full. The amount of potassium hydrate added in the case of solution D was very minute, while the ammonium carbonate added to the solution E amounted to about 5 grms. per litre, a quantity recommended by

Rose in his text-book as having a preservative effect on the strength of the solution.

These experiments, it will be observed, indicate that a sodium thiosulphate solution is more constant in the dark than it is when exposed to light, and that, when that light is weak diffused daylight, the permanence of the solution is slightly increased by using a bottle of blue glass instead of one of white glass. The solution to which a little potash had been added (D), when compared with B, shows that the potash has a small preservative effect on the thiosulphate; the amount of alkali here added was, however, very minute. The experiments with the solution E shows that the addition of ammonium carbonate has, in spite of Rose's statement to the contrary, a very prejudicial effect; it not only makes the solution more unstable, but also renders the results obtained with it at any given time more untrustworthy and less concordant with each other.

In Table II. other experiments similar to the foregoing ones are given. Here the solutions were somewhat more dilute, containing 0·01817 grm. $Na_2S_2O_3$ per c.c. A comparison of J with K indicates more clearly than one of A with B does the advantage of using a blue bottle instead of a white one, while the experiments with solution L show, as in the case of D, the good results produced by the addition of some potassium hydrate; the experiments on L, however, were unfortunately not continued as long as the others. The experiments on J, K, and L are in two particulars not exactly comparable with those given in Table I., since they were commenced three months later than the latter, and the bottles in which they were kept were nearly empty at the conclusion of the experiments. The former of these differences does not appear to have produced any measurable effect, but the latter renders the loss in strength greater towards the end of the time, when the proportion of air in the bottle became very considerable. Solution I, in Table III. illustrates this point more strikingly; here the solution was kept in a Winchester quart bottle, which was frequently opened, and which, towards the end of the experiments, was nearly empty; the loss in strength during the first year while the bottle was well filled amounted to 1·25 per cent, but another three months produced an additional change of 2·75 per cent. By the experiments on H in Table II. the prejudicial effect of a strong light is well shown, although it is probably somewhat masked during the first 40 days owing to there being a far smaller proportion of air in the bottle than was the case with the solutions J, K, and L.

In Table III. are given the results obtained from some similar experiments on solutions of potassium thiosulphate. F and G are comparable in every respect with B and A. While showing that light affects the stability of the potassium salt in the same manner as it does that of the sodium salt, they show that the former is more liable to change than is the latter.

The general conclusions arrived at may be summed up in a few words.

A solution of sodium thiosulphate is preferable to one of potassium thiosulphate. The solution should be kept in a bottle of blue glass, or preferably in the dark, and should be protected as much as possible from the access of air.

A very small quantity of potassium hydrate may be added with advantage*; the addition of ammonium carbonate is, however, decidedly injurious.

In making a standard solution of potassium bichromate care should be taken that no traces of organic matter be present in the water used.

Manurial Researches in the Lutter Experimental Field.—With potatoes, the heaviest gross crop, but the lowest nett return, was produced by farmyard manure.—*Biedermann's Centralblatt.*

* In accordance with the experience of A. V. Harcourt, *Phil. Trans.*, 1867, 117

THE

ELECTROLYTIC DETERMINATION OF COPPER,

AND THE

FORMATION AND COMPOSITION OF SO-CALLED ALLOTROPIC COPPER.*

By J. B. MACKINTOSH, Hoboken, N.J.

The quantitative determination of copper, by means of electro-deposition, offers so many advantages that it is to be preferred, when properly executed, to all other methods for ease and accuracy. The object of the present paper is to give the results of a number of experiments made during the past few months, and to indicate some sources of error which must be avoided in order to attain the necessary accuracy.

In 1867 C. Luckow, in competition for a prize offered by the directors of the Mansfield Copper Works, submitted the following process for the estimation of copper, and received, not indeed the prize, but an honourable mention for the simplicity, cheapness, and elegance of his process. He directs that the copper and the accompanying metals be obtained in the form of nitrates in solution in dilute nitric acid containing not more than 0·100 grm. of the pure acid in each cubic centimetre: to this solution is added a few drops of a solution of an organic acid, such as tartaric or oxalic, and the copper is then precipitated on platinum in the usual manner. It is claimed that the copper is obtained in beautiful reguline form, while zinc, iron, and nickel are not precipitated at all.

In adapting this method to the analysis of copper alloys I dissolved the alloy in nitric acid, evaporated the solution to dryness to get rid of the excess of acid, dissolved the residue in water with the addition of a few drops of nitric acid to dissolve the basic nitrate of copper formed, and to this solution added four or five drops of a concentrated solution of citric acid. This solution was then precipitated in a platinum dish with a current from two Bunsen cells of about one quart capacity. In precipitating several samples at once I have it arranged so that the whole current traverses the row of dishes, the negative pole of each set being connected with the positive pole of the next succeeding one. In this case if n be the number of dishes, then $n+1$ is the number of battery-cells of that size used.

Some of the results obtained by this method, and on duplicate portions by precipitation from sulphuric acid solution, are as follows:—

	Sulphuric Acid.	Nitric+Citric Acid.	Error.
1 grm. pig copper ..	98·00	99·42	+1·42
,, ,, ..	99·80	101·22	+1·42
,, ,, ..	98·92	100·41	+1·49
,, ,, ..	98·72	100·27	+1·55
,, ,, ..	99·60	100·45	+0·85
1 grm. brass	65·83	66·93	+1·10
,, ,, ...	65·83	66·58	+0·75

In only one case was a smaller percentage obtained by the use of this method, and in that case the precipitation of the copper was not complete. In many cases, also, in which the amount of error was less than 1 per cent. small quantities of copper escaped precipitation, and were afterwards found in the solution.

The metallic precipitate thus produced is of a much lighter colour than ordinary copper from the electrolysis of the sulphate solution, but it is, as Luckow says, deposited in beautiful reguline form, which, however, hardly compensates for the error of perhaps 1 per cent or more, which we see is, as a general rule, the case.

Moreover, if the current is strong, after all the copper has been thrown down, zinc will be deposited on the surface of the copper, as a dark coating, which may be recog-

* *Transactions of the American Institute of Mining Engineers.* Read at the Virginia Meeting, May, 1881.

	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*
Carbonic acid	0·0273	0·0316	0·0350	0·0344	0·0322	0·0324	0·0346	0·0283
Equivalent to carbon ..	0·00744	0·00862	0·00954	0·00938	0·0088	0·0088	0·0094	0·00771
Water..	0·0094	0·0108	0·0089	0·0094	0·0054	0·0045	0·0074	0·0054
Equivalent to hydrogen ..	0·00104	0·00120	0·00100	0·00104	0·0006	0·0005	0·00082	0·0006
Ratio of carbon to hydrogen	7·15	7·18	9·54	9·0	14·6	17·6	11·46	12·42
Copper			0·9683	0·9687				
Total			0·97884	0·97912				

nised as such by dissolving in dilute sulphuric acid and applying appropriate tests.

In the presence of the organic acid the formation of peroxide of lead on the positive pole is hindered, and in its absence it is very difficult to precipitate the whole of the copper from the solution.

In order to obtain sufficient material for analysis, to ascertain the cause of the excess in weight, the precipitation of the copper was made on a piece of platinum foil. On attempting to strip the deposit from the foil I found that it was extremely brittle, and scaled off easily,—so brittle, indeed, that it could be reduced to an impalpable powder in an agate mortar with very little trouble. This agrees exactly with the description of the allotropic copper of M. P. Schutzenberger, which was published in *Comptes Rendus* (vol. lxxxvi., part 2). M. Schutzenberger obtained the material he describes by the electrolysis of a 10 per cent solution of the neutral acetate of copper. He found that the product contained from 5 to 10 per cent of suboxide of copper. In the material which I prepared from the nitric and citric acid solution I did not find *any* suboxide of copper; on the other hand, both carbon and hydrogen have been detected and estimated. These latter were determined by combustion of the finely divided sample in oxygen; the method used to estimate the suboxide of copper was that of Hampe.* However oxygen is present, though, as this test shows, not as cuprous oxide.

The results of the analyses of several samples, prepared at different times, are given above. The determinations were all made on the amount of 1 grm.

The results which are bracketed are from duplicate analyses. These samples were all prepared from the nitric and citric acid solution. *a*, *b*, and *c*, *d* were prepared simultaneously, the solution of *b* containing a little more citric acid than that of *a*, and *c* *d* more than either. The samples *e*, *f*, *g*, and *h* were heated to about 100° C. for fifteen minutes before being introdued into the combustion-tube, and the samples *c*, *d*, *e*, and *f* were the same. The results given under *h* are low, probably due to imperfect oxidation.

It will be seen that there is a deficiency of 0·02116 and 0·02088 respectively in the total of the duplicate analyses *c* and *d*. The precaution was taken in one case of passing the products of the combustion over a red-hot layer of oxide of copper, to make sure that no hydrocarbon was distilled out by the gradually increasing heat, and so escaped oxidation. The results in this case, however, differed in no material manner from those already obtained. We must therefore conclude that this deficiency must consist either of *oxygen* or *nitrogen*, or of a mixture of both. I have already mentioned that there is no oxygen in the form of cuprous oxide present, so that it must, if present, be combined in some other form. The following synthetical experiments seemed to indicate that *nitrogen* was also an essential constituent.

These experiments were conducted as follows:—Solutions were prepared of nitrate and of sulphate of copper; to these solutions were added respectively citric acid, tartaric acid, and alcohol. All three of the solutions of the nitrate furnished the brittle deposit, while all three of the sulphate solutions gave a tough deposit of apparently ordinary electrotype copper. The amount of copper was determined in 1·0008 grms. of the precipitate from the sulphate solution containing alcohol, and found to be 0·9991.

* *Zeitschrift für Analytische Chemie*, 1878, p. 127

This difference is probably due to impurities in the copper, which was prepared in the first place from the commercial sulphate, which contained lead and other impurities.

During the electrolysis of the nitrate solutions containing citric acid, a very strong odour of hydrocyanic acid was perceptible.

If an insufficient amount of organic matter be added the precipitated copper obtained is not brittle, but it nevertheless contains carbon and hydrogen, and gives a total result less than 100 per cent. This is due to admixture of ordinary copper. It is not possible to divide such a precipitate sufficiently finely to ensure perfect oxidation.

The amount of nitrogen present in the nitric-citric precipitated copper, was determined by heating the finely pulverised sample in a vacuum and collecting the gases evolved. The products thus obtained were hydrogen, carbonic acid, and nitrogen. Although in this case it was probable that an excess of oxygen would be present, yet the analytical results showed the absence of that gas in any appreciable quantity.

The volumes given are those of the dry gas at 0° C. and 760 m.m.

1 grm. heated in vacuo.		½ grm. in Oxygen.	1·15 grm. in Oxygen.
Gas obtained	9·95 c.c.	8·23 c.c.	17·52 c.c.
CO_2 absorbed by KOH ..	4·72 ,,	7·35 ,,	15·70 ,,
Gas not CO_2	5·23 ,,	0·88 ,,	1·82 ,,
Oxygen added	7·77 ,,		
	13·00 ,,		
Volume after explosion ..	7·44 ,,		
Loss—Water	5·56 ,,		
No CO_2 formed: *Hydrogen*	3·71 ,,		
Residue: *Nitrogen*.. ..	1·52 ,,		

These residues, treated with moist phosphorus to absorb oxygen, and then with KOH, did not change, proving the absence of oxygen.

The circumstances of formation were such as to preclude the existence of hydrogen, therefore these residues must be nitrogen.

The percentage results in the foregoing three cases are respectively for nitrogen—0·191, 0·221, 0·199; and in the two last for carbon—0·792, 0·736. The ratio of $\frac{C}{N}$ being 3·6 and 3·7.

One sample of the product, made with tartaric acid, weighing 2 grms., was also analysed for nitrogen, and 1 c.c. of dry nitrogen at 0° C. and 760 m.m. obtained. It is difficult, when working on such small quantities of gas, to obtain very accurate results.

Some of the allotropic copper prepared from the chemically pure acetate, according to M. Schutzenberger's directions, and which therefore could not contain nitrogen, and also some prepared from an acetate of copper containing nitrate of soda, were compared and analysed. The material thus obtained was apparently the same in both cases, and differed considerably in some of its properties from the nitric-citric acid solution precipitate. In appearance, brittleness, and composition there was no essential difference, but it was very unstable and liable to oxidise; in fact, it was not possible to preserve it of con-

stant composition in the air, while the nitric-citric precipitate can be preserved indefinitely without change.

Two samples, of 1·0014 and 1·0004 grms. respectively, were weighed out. The first was heated for about fifteen minutes to 100° C. in an air-bath; on cooling and weighing it had gained 0·0215 grm. The second sample was exposed to the air at the ordinary temperature for two hours and three-quarters: at the end of that time it had gained 0·0225 grm.; it was then heated to 100° C. for fifteen minutes, when it lost 0·0020 grm., giving a net gain of 0·0205 grm.

The amounts of carbon and hydrogen were determined in the second sample of the material from the acetate solution containing nitrate of soda, and in two samples from the chemically pure acetate preparation.

	$Cu(C_2H_3O_2)_2 + NaNO_3$.	$Cu(C_2H_3O_2)_2$	
Amount taken..	1·004 grm.*	1·0000 grm.	1·0000 grm.
CO_2 found ..	0·0145 ,,	0·0175 ,,	0·0154 ,,
Equivalent to C	0·00395 ,,	0·00477 ,,	0·0042 ,,
H_2O found ..	0·0081 ,,	0·0092 ,,	0·0081 ,,
Equivalent to H	0·0009 ,,	0·00102 ,,	0·0009 ,,
Ratio, C : H ..	4·4 ,,	4·676 ,,	4·666 ,,

The cause of the rapid oxidation of these samples seems to be that the deposit is very porous, while that from nitric solutions is very dense.

M. Schutzenberger mentions that he had at one time a considerable quantity of this allotropic copper (*sic*) reduced to powder and dried in a vacuum, which, at the moment when air was admitted to it, was transformed to ordinary copper, attended by a considerable evolution of heat. The amount of oxygen he found was not altered by this occurrence.

To account for this phenomenon he frames the theory that the allotropic copper corresponds to cuprous copper, and that the molecular change to cupric copper is accompanied by the development of heat. But we can easily see how liable to spontaneous oxidation a large quantity of such finely divided material would be, when it contains both carbon and hydrogen in a weak state of combination, and it is unnecessary to suppose the existence of another form of metallic copper to account for the phenomena noticed.

The practical conclusions to be drawn from these results are, that some organic matters, and in all probability all, in the presence of nitric acid in the copper solution undergoing electrolysis, cause erroneous results; that from a nitric acid solution, with no organic matter, it is extremely difficult to separate all the copper; and that the old method of electrolysis from the sulphate is the best.

Discussion.

Dr. Egleston, New York—The paper which I have just read is one of great interest. It represents the work of my assistant, who is a man of great skill in this particular line of his profession, for nearly a year in my laboratory. There will certainly be in this connection two subjects which must come up for discussion in the Institute before a great while, and these are "What is copper?" and "What copper is," and which will have, in a commercial point of view, as great or even greater interest than the similar discussion which took place a few years ago about steel. What is sold in the market as copper may contain anywhere from one-tenth to one per cent of foreign material. Out of a very large number of analyses of the ordinary commercial coppers, the best sample that we were able to get contained only 99·91 per cent of copper. This is much more important than it would at first sight appear to be, because there is a direct relation between the purity of the copper and its electrical conductivity. The presence of so small a quantity as nine-hundredths of a per cent of foreign matter may be sufficient to take away more than 10 per cent of the conducting power of the material. The manufacture of pure copper for the application of electricity to the industrial arts, which will in a few years be one of the greatest commercial questions to be solved, is therefore much more important than is generally supposed. This is not only true of copper, but of its alloys. Certain alloys made from metals of high quality have become of great commercial importance within a few years; but great difficulty has been experienced in manufacturing them, for while some of the alloys do not stand the test, and are therefore rejected at once, others will stand it for a few weeks or months, and will then become brittle and worthless. I hope, therefore, that this matter will receive from the chemists of the country the careful attention which it deserves.

The paper of Mr. Mackintosh is the result of analyses of over seventy samples of copper and brass, from different parts of this country, in all stages of their manufacture. There are many samples of copper in which less than one-half of 1 per cent of foreign material has made the copper perfectly worthless for certain large industrial applications, and it requires but an extremely small amount to render it worthless for processes of conductivity. A change takes place in the alloys of copper which is partly physical and partly chemical, which may render the alloy useless after a certain time, although it may satisfactorily undergo all the tests immediately after its manufacture. In view of the very small quantities of foreign matter which make the changes in copper, the question which Mr. Mackintosh has brought before the Institute is one of very great importance.

Whatever may be the method which is used for analysing copper there is one thing which must be very carefully taken into account, and that is the influence of organic matter in solution. It makes no difference what the method is; if organic matter of any kind gets into the solution the analysis of the copper will be likely to be incorrect.

I have seen very large works make the determination of copper in porcelain vessels with platinum strips. We have found that under such circumstances it is impossible to get accurate results, for if even very small quantities of copper become detached from the strips and fall upon the porcelain the copper is in danger of oxidation. Mr. Mackintosh has devised a very ingenious arrangement of copper wires switching into mercury, by which the whole current of the battery passes under a number of dishes, equally divided amonst them all; and if there is any necessity for so doing, he can switch out one or two vessels and pass the current through the remainder. This system has been in use in my laboratory for over two years, and has worked most satisfactorily; it is so arranged that each platinum dish rests upon a metallic support, which passes underneath the vessels, and is connected with the battery by means of thumb-screws and wires.

Extremely minute amounts of cobalt, nickel, oxide of copper, and zinc will reduce the conductivity of the copper wire very largely. In fact almost everything, except silver, which may be contained in the copper will reduce it. In the case of iron wires I had occasion recently to ascertain that oxide of iron, which is generally neglected in the analysis of copper wires used for electrical purposes, is one of the most deleterious materials ever found in it.

The experiments which I have been making during the last year have been made with wires having different mechanical and chemical compositions; and in order to be certain of the results we have gone so far as to solder wires together, some of which were afterwards drawn down, and others tested without being drawn, but no appreciable difference was found. Oxide of iron is certainly not evenly distributed throughout the mass, and causes the fibres to separate in such a way, both in the interior and the exterior of the rod, that this want of homogeneity may possibly have as direct an influence as

* Oxidised by exposure to air and heating in air-bath before combustion.

that of the presence of an alloyed impurity. There is no doubt whatever about the effect of cobalt, nickel, and zinc. A series of experiments were made by the first Cable Company as to their effect. which have been fully confirmed by my analyses and experiments during the last year. The presence of silver would have the effect of raising the conductivity even in the presence of nickel and cobalt, since its conducting power is much higher than that of copper.

Mr. S. P. Sharples, Boston—If there is any one metal which has interested me more than another during the last fifteen years, that metal has been copper. While I was a student in the Lawrence Scientific School under Dr. Wolcott Gibbs, during the winter of 1866-7, he called my attention to some analyses that were made by Mr. E. V. McCandless, in the laboratory of the school. These analyses were published in the *American Journal of Science and Arts*, January, 1865, the paper bearing date October 1st, 1864. He found that he could completely precipitate copper from a sulphuric acid solution, using a platinum plate for the positive and a platinum dish for the negative electrode. The copper after precipitation was carefully washed with distilled water, and dried *in vacuo* over sulphuric acid.

Dr. Gibbs suggested that I should take some pure copper and dissolve it in sulphuric acid with the addition of some nitric acid, and then evaporate to dryness over a lamp so as to expel the nitric acid and the excess of sulphuric acid, and then precipitate and weigh. After weighing, the copper was again dissolved in the same dish, and again evaporated to drive off excess of acid, dissolved in water, precipitated again, and weighed. This operation was repeated several times with closely agreeing results, thus confirming Mr. McCandless's work. The paper by Dr. Gibbs was published in German in *Fresenius's Zeitschrift für Analytische Chemie*, vol. iii., 1864. In vol. viii. of the same journal is a long paper by C. Luckow, in which he says he had first described this method in *Dingler's Journal* in 1866, or a year after it was described by Dr. Gibbs. I have been particular in regard to dates, because this method, or some trifling modification of it, is re-published every few years as something new.

I have made many hundreds of determinations of copper by this method, and with uniformly good results. In the course of this work I have found that many of the precautions that we originally considered necessary may be omitted. In the first place a little nitric acid in the solution does no harm. The evaporating to dryness is time wasted. Care should be taken, however, not to have too great an excess of acid of any kind present. If from any cause we find that too much free acid is present in the solution, it can be readily neutralised by the addition of a little ammonia water, not quite sufficient to neutralise the acid. The drying *in vacuo* is also unnecessary. Dr. Gibbs suggested that the water be removed by a little alcohol, as this would evaporate in less time than water: this was tried with satisfactory results. The next suggestion (whose I know not) was that the alcohol might be burnt off: this also works well.

The process of analysis which has been followed in my laboratory since 1871 is as follows, and it is just the same whether the substance be a matte, an alloy which does not contain metals thrown down by the battery in an acid solution, or an ore:—Two grms. of the substance, if it contains more than 10 per cent of copper, or 4 or 5 grms. if it is poor in copper, are weighed into a porcelain dish. This is treated with 5 c.c. of strong sulphuric acid, and then a little nitric acid is added from time to time until the action ceases. It is then heated to boiling over a lamp, allowed to cool and diluted to about 50 c.c., boiled, and filtered. If the substance is well ground a single treatment is generally sufficient; if, however, any black residue remains, this treatment is repeated. If there is any lead in the ore it is converted into a sulphate, and remains behind on the filter; the trace that goes through may be neglected, since it is not precipitated with the copper. The copper solution is filtered directly into the platinum dish, which should hold about 200 c.c., though with care one holding 100 c.c. can be used.

This operation generally is completed in half an hour from the time the ore is weighed. The precipitation takes care of itself; the dish being placed in the circuit when the laboratory is left in the evening, in the morning we find the work finished. The solution is tested by taking out a drop and putting it on a white plate with a drop of hydric sulphide: if the copper is completely precipitated the dish is removed from the battery, the solution poured out, and saved if necessary for the determination of other substances. The dish is then washed with pure water, followed by alcohol; the alcohol is then drained out as completely as possible, and the little that adheres to the dish set fire to. This operation not only serves to dry the copper, but it also prevents the oxidation during the drying. A very slight blueing of the copper does no harm, as it will not perceptibly change the weight. The whole operation, from the time the precipitation is complete until the copper is weighed, need not take more than ten minutes.

Within a few months I have had occasion to test the method very carefully. Certain parties were dissatisfied with my results, which they claimed were too high, and demanded my samples. The samples had already been sent to an eminent chemist, who returned them to me with his method of analysis. His results were about one-tenth of a per cent higher than mine, while the method employed by him involved about five times the work. I have had no further advices from the dissatisfied parties, though they have had the samples for two or three months.

This method bids fair to become the standard method of copper determination in this country. I know of some heavy contracts in which it has been inserted as part of the agreement.

In connecting the precipitating dish with the battery, I find it is better, when more than one dish is used, to connect the positive pole of the battery with a sheet of metal or wire on which both of the dishes are set, and to connect the platinum strips with the wire proceeding from the other pole of the battery. In this way the current is divided between the cells, and the resistance is less than if the cells are in series. I find that two small Grove cells are sufficient for the purpose.

The commercial allowance for variations in analyses of copper ores is one-half of one per cent; the actual variation on analyses made by this method in duplicate does not often exceed one-tenth of one per cent.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 1, 1881.

Prof. H. E. Roscoe, President, in the Chair.

The ballot for the election of Fellows did not take place, as the requisite number of Fellows was not present. The President, in postponing the ballot to the next meeting (December 15), said that he hoped that the Fellows would endeavour to be present on that occasion, so that the ballot might take place.

The following certificates were read for the first time:—F. Barkas, E. D. Chester, J. Gray, H. E. J. Irons, F. H. Lescher, J. P. Laws, H. F. Moore, D. O. Masson, T. Perry, J. R. Parker.

The President then called on Dr. Armstrong to read a paper entitled "*Researches on the Laws of Substitution*

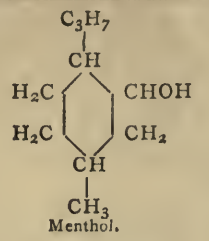
in the Naphthalen Series (Part II.)." In this communication Dr. Armstrong describes the results which Mr. Graham and himself have obtained in continuing their examination of certain naphthalen derivatives. The product of the action of cold sulphuric acid on β-naphthol, described by Mr. Stallard and Dr. Armstrong at the last meeting of the Society in June, proves not to be identical with the isomeric naphthol-sulphonic acid patented by Mr. Dixon on behalf of Dr. Rumpf (CHEMICAL NEWS, vol. xliv., p. 46), but to be merely β-naphthyl-sulphonate, $\beta C_{10}H_7OSO_3H$. The same substance may be obtained far more easily and in theoretical amount by the action of SO_3HCl on a cold solution of β-naphthol in carbon disulphide. It is converted into mono-brom-naphthol, identical with that from bromine and β-naphthol, on treatment with bromine, but yields *di*-nitro-naphthol on treating with dilute nitric acid. The formation of a dinitro compound is explained by the fact that mono-nitro-naphthol is readily converted into the dinitro compound, even by dilute nitric acid. β-naphthyl-sulphate is converted into Schæffer's β-naphthol-sulphonic acid by heating on the water-bath. When acted upon by SO_3HCl it yields the sulphate of Schæfer's acid. This sulphate is converted by the action of bromine into bromo-naphthol-sulphonic acid, identical with that produced by brominating Schæffer's acid, or by acting on ordinary bromo-β-naphthol with SO_3HCl. Bromine and the sulpho-group, therefore, do not assume the same position when the sulphate is treated with bromine and SO_3HCl respectively. β-naphthyl acetate in like manner yields the acetate of Schæffer's acid when acted upon by SO_3HCl. The author proposes to examine the behaviour of other β-naphthylates, as modifications of the OH group appear to lead to important modification of the laws of substitution. Dr. Armstrong also stated that the third isomeric naphthalen-disulphonic acid which Mr. Graham and himself obtained gave a chloride fusing at 126°. On treatment with PCl_5 this chloride is converted into a dichloro-naphthalen, which appears to be identical with θ-dichloro-naphthalen. By acting on naphthalen with SO_3HCl they have obtained a fourth disulphonic acid. Its chloride melts at 180°, and yields γ-dichloro-naphthalen on distillation with phosphorous pentachloride.

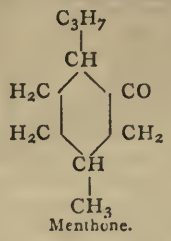
Mr. E. H. RENNIE then read a paper "*On Benzyl-phenol and its Derivatives.*" This investigation was undertaken to obtain, if possible, more definite information regarding the derivatives of benzyl-phenol than is given by Paterno and Fileti, who first prepared and examined these bodies (*Gaz. Chim. Ital.*, iii., 121, 251). The benzyl-phenol was obtained by the action of benzyl-chloride on phenol in the presence of zinc, the mixture being kept cool. By the action of a slight excess of sulphuric acid over that required by theory, a mono-sulphonic acid was obtained; also its ammonium and barium salts. These bodies are crystalline, and the salts are but sparingly soluble in water; the dibarium salt is almost insoluble. By the action of dilute nitric acid (1 : 1) on potassium-benzyl-phenol-sulphonate in fine powder, a crystalline yellow salt was obtained, which proved to be a mono-nitro-benzyl-phenol-sulphonate, $C_7H_7,C_6H_2(OH)(NO_2)SO_3K$; it yields an orange dipotassium salt. By the action of bromine on potassium benzyl-phenol-sulphonate, a white salt, $C_7H_7,C_6H_2(OH)BrSO_3K$, was obtained. By the action of strong nitric acid on the above potassium salt, a trinitro-derivative was prepared, giving an orange-red potassium salt. The author considers benzyl-phenol to be a para-derivative. He endeavoured to prove this point by oxidising the methyl-ether of the phenol with chromic liquor, but only benzoic acid was formed. By oxidation with alkaline permanganate neither benzoic nor anisic acid was formed, but a white crystalline substance, soluble in alcohol, and melting at 60°, which is still under examination. The author promises to lay before the Society the results of a further investigation on this subject.

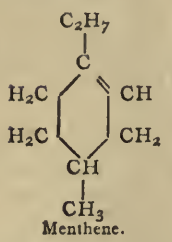
"*Note on the Action of Ethylic Chloro-carbonate on Benzene in the Presence of Aluminic Chloride,*" by E. H. RENNIE. Ethyl-chloro-carbonate in contact with aluminic chloride in the cold, decomposes violently into carbonic anhydride and mono-chlor-ethane; if benzene be present the mono-chlor-ethane acts upon it, and ethyl-benzene is formed. If ethyl-chlor-acetate be substituted for ethyl-chloro-carbonate, no reaction takes place in the cold, and on heating, though some hydrochloric acid is evolved, no ethyl-phenyl-acetate is formed.

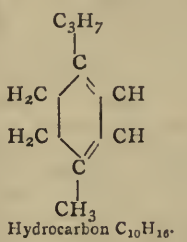
Dr. ARMSTRONG said the investigation was of great interest, as it was the first case in which the substitution-products had been investigated with the introduction of a positive radical. He did not think the substance was a para-derivative, because the trinitro- body gave an orange salt, which should have been crimson had the benzyl been in the para-position; it was, therefore, more likely to be in the ortho- or perhaps meta- position.

The SECRETARY then read a paper "*On Peppermint Camphor (Menthol) and some of its Derivatives,*" by R. W. ATKINSON, B.Sc., and H. YOSHIDA. Peppermint camphor is usually contaminated with oily matters which accompany it in the plants. After repeated purification by distillation, careful pressing between filter-paper, &c, the authors obtained menthol melting at 42·2°, solidifying at 40·3°, and boiling at 212° (cor.). Mr. Moriya has shown (*Jour. Chem. Soc.*, March, 1881), that menthol when heated with acid bichromate solution at 120° yields an oil boiling at 204°, having the composition of menthone, $C_{10}H_{18}O$. The authors have repeated these experiments, using large quantities. By repeated treatment with fresh oxidising mixtures the product gave a positive rotation, $[\alpha]=+21°$. Menthone is a colourless mobile liquid, neutral to test-papers, soluble in alcohol, chloroform, benzene, and bisulphide of carbon; insoluble in water. When cohobated repeatedly with zinc chloride a hydrocarbon was obtained, in too small a quantity, however, to admit of its identification. If a solution of menthone in petroleum be heated with sodium, the solution formed decomposed by carbonic acid, the product shaken with water, rapidly separated from the oily layer and set aside, minute crystals of menthol are obtained. Menthol, therefore, stands to menthone in a similar relation to that which borneol stands to camphor. The menthol thus produced from menthone melts at 42·2°, but has a rotatory power of only −39°. The specific rotatory power, the specific gravity and rate of expansion, and the molecular refraction of menthone were determined by the authors. The molecular refraction was 75·3, using Brühl's numbers for C, H, and O; the calculated value is 75·1, the carbon atoms not being doubly combined. The authors then prepared menthene, $C_{10}H_{18}$, by heating menthol with zinc chloride; the crude product was purified by careful fractionation and long digestion with sodium. The pure product distilled over constantly at 167·4°. Its specific rotatory power, its specific gravity, and rate of expansion were determined. Its molecular refraction was found to be 74·045; calculated for carbon atoms in single union, 71·82; or supposing one pair of carbon atoms doubly united, 73·82. Menthene is a colourless mobile liquid, moderately soluble in ether and alcohol, more soluble in benzene, turpentine, and petroleum. Its colour resembles that of cymene: fuming hydrochloric acid yields $C_{10}H_{19}Cl$. By treating menthol with hydriodic acid, distillation, treatment with caustic soda, sodium, &c., a colourless hydrocarbon was obtained, which consisted chiefly of $C_{10}H_{16}$ with a small quantity of $C_{10}H_{18}$, or $C_{10}H_{20}$. The authors then determined the specific volumes of these menthol derivatives, but do not place much reliance on the results. The authors conclude with some remarks on the constitution of menthol. From the above experiments they think that there is great similarity in constitution between camphor and menthone. Zinc chloride, when it acts upon camphor, produces cymene; with menthone, a hydrocarbon containing two atoms of hydrogen more than cymene. They give the following as the probable constitution of these bodies:—


Menthol.


Menthone.


Menthene.


Hydrocarbon $C_{10}H_{16}$.

These formulæ receive considerable support from their close alliance to Kekulé's formula for camphor. The authors propose to study the action of nitric acid on menthol.

Dr. WRIGHT said that the constitution of menthene given by the authors could not be accepted, as it did not explain the direct combination of bromine and menthene to form a tetra-bromide, $C_{10}H_{18}Br_4$, mere traces of hydrobromic acid being evolved (*Chem. Soc. Journ.*, 1876, p. 2).

The SECRETARY then read a paper "*On the Production of Oxalic Acid from Paraffin Oil*," by J. GALLETLY and J. S. THOMSON. The authors treated a paraffin oil, sp. gr. about 0·800 obtained by the destructive distillation of shale with twice its volume of nitric acid, sp. gr. 1·3 The action is at first violent, but has to be completed with the aid of a gentle heat. After the reaction is finished the liquid separates into three layers. The lower one, consisting of the excess of acid, on evaporation at a gentle heat, yielded a crop of yellow crystals, which, after recrystallisation, were obtained in a colourless condition. They proved to be pure oxalic acid. The authors identified the body by its reactions and analyses of the acid, and its calcium salt.

The Society then adjourned to December 15, when a paper "On some Higher Oxides of Manganese and their Hydrates," Part II., by V. H. Veley, will be read.

NOTICES OF BOOKS.

A Manual of Practical Assaying. By JOHN MITCHELL, F.C.S. Edited by WILLIAM CROOKES, F.R.S. Fifth Edition. London: Longmans, Green, and Co.

CONCERNING the value of Mitchell's Manual practical men are decidedly unanimous: there is no work in the English language by which it can be superseded. Nevertheless, here, as in every application of science to technical pursuits, changes are incessantly taking place. On the one hand, new and improved methods are being from time to time devised, and such of them as when carefully tested show some distinctive advantage in accuracy, convenience, or economy of time and materials, require to be generally known. On the other hand, the demands made upon the assayer are becoming more stringent. He is expected to work with greater accuracy, and at the same time with greater speed, than his predecessors. Further, whilst formerly the ores which came under his hands were derived from few sources, and were consequently of generally known composition, he has now to deal with minerals brought from all parts of the world, and is frequently compelled to modify his routine processes on account of the presence of some unusual constituent. Hence the rule-of-thumb is at an end: the assayer must be a man of science, and have at his command the resources of analytical chemistry. It is from this point of view that the editor has set out in modifying and extending the work before us. Methods which have been superseded have been omitted, whilst new and improved processes have been introduced in their room, and thus, without sacrificing those features which have won for Mitchell's "Manual" in its earlier editions such general favour, it has been brought into harmony with the wants of the day.

When the fourth edition appeared there was, we remember, some little division of opinion as to whether the Editor had been well advised in retaining the nomenclature and notation of what is now called the "old chemistry," *i.e.*, that generally prevalent about the middle of the century. Now, however, as all the chemical schools have adopted these changes, and as they are incorporated in all manuals and text-books, it became imperative to recognise them in the present volume as in all other technological treatises. This accordingly has been done. We are not ignorant of the conservative turn of mind prevalent among many practical assayers, but we trust that they will see the necessity of conforming to what is now a universal practice.

The valuable electrolytical methods for the quick and accurate determination of various metals, *e.g.*, copper, are here fully described, and will doubtless be more and more widely introduced into practice. Indeed it is probable that, so far at least as inorganic analysis is concerned, electricity has a great part to play.

Hopes were entertained at one time that a still more modern analytical instrument, the spectroscope, would by this time have effected an even more striking simplification, especially in the assay of the precious metals. Hitherto the attempt has failed in the most competent hands, and the obstacles discovered are of such a nature as to leave little hope for the future. It appears that in alloys the spark elects as its vehicle the one of the metals present which is most rapidly volatilised. Hence, in alloys of copper containing from 20 to 25 per cent of gold, the spectrum of the latter metal is scarcely visible. Further, it is impossible to obtain alloys of gold so perfectly homogeneous that the minimum trace which yields the spectrum may safely be taken as a representative of the entire ingot.

First Results of Studies on the Formation of Colouring Matters by the Electro-Chemical Way. (Premiers Resultats des Etudes sur la Formation des Matières Colorante par voie électro-chimique.) Exhibited by F. Goppelsroeder. Mulhouse: Veuve Bader et Cie.

WE have here an account of some exceedingly interesting experiments performed by Prof. Goppelsroeder, the results of which have been on view at the Paris Exhibition. It appears that as far back as April 14th, 1875, the author read before the Chemical Committee of the Industrial Society of Mulhouse a preliminary notice on the action of free ozone and of the voltaic current upon certain substances belonging to the aromatic series. Since that time he has carried out these investigations with great care, and has arrived at results which may not improbably become of considerable practical importance, and which must at any rate be recognised as of scientific value. He himself gives the following general sketch of what he has already in part accomplished and hopes to contemplate in the future:—

"To make use of the galvanic current for decomposing water and its typical derivatives, and arrive at colouring matters of the different series by adding to the water any solution of the primary aromatic bodies which may be converted into dyes. To imitate by this electro-chemical method the purely chemical methods usually employed in obtaining colouring matters. To incorporate with water or with one of its typical derivatives a mixture of any

solution of aromatic matters with organic substances or organic electrolytes, whose atoms or groups of atoms, set free by the action of the electric current, may take part in the metamorphoses in the molecules of the aromatic bodies, so that the hydrogen or other atoms of the latter may be replaced by other atoms or groups of atoms of the substances added." "To effect inversely at the negative pole a retrogressive metamorphosis so as to arrive at the aromatic bodies which had been the point of departure, or which are theoretically supposed to be. To arrive even at such primary matters as benzol, toluol, naphthalin, anthracen, &c.", "To seek to discover the process of the formation of colouring matters in the animal and vegetable kingdom, and to ascertain if such are not also formed galvanically."

At Paris the author exhibited 71 specimens of coal-tar colours, black, red, blue, violet, brown, and yellow. We do not find mention of any green colour. There were displayed also 36 samples of silk dyed electrolytically. The processes employed in the production of the colours are exceedingly simple, and will be rendered much less expensive by the substitution of *e.g.*, a Gramme machine for the Bunsen batteries used to give a current. The author hopes to develop an electro-chemical dyeing process, the colours being fixed upon the fibre at the moment of their formation.

Principles and Objects of the Chemistry of Coal. (Grundzüge und Ziel der Steinkohlen-Chemie.) By Dr. F. Muck, Principal of the Mining Laboratory and Teacher of Chemistry at the Westphalian Mining School at Bochum. Bonn: Emil Strauss.

The author of this work makes in his preface the startling, but perfectly true, remark that "in the manuals and textbooks of chemistry, whether pure or technological, there is to be found little concerning the chemistry of coal, and in that little there is a portion either erroneous in point of fact or based upon false and arbitrary assumptions." Whilst an enormous amount of the highest chemical talent has been applied to coal-tar, the raw material, the coal itself, has received but a small fraction of the attention which its technical importance might justly claim. In accordance with the requirements of his position, Dr. Muck fell to work to collect the matter bearing on this subject which exists scattered in geological and metallurgical works and in the scientific journals, and to submit it to a searching criticism. The result has been the following monograph, which we think will be exceedingly welcome to a great number of scientific men. The author gives here in succession certain generalities on the percentage composition of coals and on their proximate constituents. He then proceeds to consider the classification of coals according to their behaviour when heated either in the presence or absence of air. Next is discussed the connection existing between the properties of coal, especially its fusibility; yield in coke; degree of tumefaction when heated and nature of flame, with the percentage composition, exclusive of the ash. We then come to a consideration of the influence of the mineral constituents upon the yield of coke. The fifth chapter is devoted to the "mechanically admixed" ingredients of coal, exclusive of ash and of the sulphur compounds. Under this head the author treats of the different kinds of coal, the resinous soluble constituents, the proportion of water, and the hygroscopic character, and the gases occluded and given off. The author is still engaged with researches on the soluble constituents. He quotes the experiments of Guignet, who obtained 4 per cent of soluble matter from finely-powered coal, and by treatment with nitric acid succeeded in preparing oxalic acid and trinitro-resorcin. In his attempts at obtaining resorcin from coal there came over merely ammonia and aniline. This subject is the more interesting, since the manufacture of the coal-tar colours cannot occupy a sound position till its raw materials can be bought at any time in open market as required without the perilous necessity of "contracting." We next come to the mineral, and especially the sulphuretted constituents; the changes which coal undergoes on exposure to the air, weathering, and spontaneous ignition. In the eighth and last chapter the author expounds existing views on the chemical processes involved in the formation of coal, and treats of the experiments on the artificial production of coal, and the relations of coal to other fossil fuels. Dr. Muck inclines to the view of Goeppert that not merely lignite, but true coal, may have been formed in the wet way and in a relatively short time. Hence he ascribes little direct importance to the experiments of Cagniard, Latour, and Violette. He infers from Frémy's researches that the impressions of plants in coal and coal-shales prove, not that the coal is derived from such plants, but that it must once have existed in a plastic condition.

An appendix describes the method of calculating the heating-power of coal from its elementary composition, and gives a general view of the educts of coal and their utilisation.

Dr. Muck's monograph ably supplies a very distinct want in the chemical literature of the modern world.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 20, November 14, 1881.

Researches on Electrolysis.—M. Berthelot.—The limit of effective electromotive forces is uncertain when there is polarisation. To take account of this, and to show if it enters into the common law, it is necessary to know the real nature of the compounds brought into action and their formation-heat. But here, as in thermochemistry and in a multitude of natural phenomena, we encounter the mechanical notion of the least action.

Synthesis of the Nitrogenous Colloids.—E. Grimaux.—The author defines the proteic matters as nitrogenous albumenoids which may be resolved by hydration into amidic acids, carbonic acid, and ammonia. Coloured reactions do not belong to the albumenoid molecule; thus the red tinge produced by Millon's reagent indicates a residue of tyrosine. He supposes that the amidic acids formed by the decomposition of the proteic molecule are fixed there with loss of water, forming condensed anhydrides, analogous to the polylactic acids of Wurtz and Friedel. As there are no mixed anhydrides of the amidic acids known, the author took up the condensation-product of a single amidic acid, the aspartic anhydride of Schaal. If this body is heated for two hours to 125° to 130° with half its weight of urea, it is transformed into a thick mass, perfectly soluble in boiling water. The solution is gummy, filters with difficulty, and possesses all the characters of the colloids; it is precipitated by the acids, the alkaline salts, by magnesium and aluminium sulphates, the salts of iron, mercury, and copper, by tannin; all these precipitates are gelatinous, and so thick that with concentrated solutions they do not fall out if the vessel is inverted. The precipitates formed by hydrochloric and nitric acids dissolve in an excess of the acid; the addition of water causes a separation of gelatinous flocks. The jelly yielded by acetic acid is converted on drying into translucent plates, presenting the aspect of dried albumenoid matters; it is then insoluble in boiling water, which merely softens it. It dissolves in potash; its alkaline solution, if treated with copper sulphate, takes a violet colour, having absolutely the same shade as the proteic substances. The solution of poly-aspartic amide may be isolated by dialysis. We thus obtain a liquid which dries up in a vacuum to a translucent mass, presenting the same appearance as the

precipitate formed by acetic acid, from which it is distinguished by its solubility in water. If the solution is evaporated, not in a vacuum, but on the water-bath, the residue becomes in great part insoluble. If it is possible to produce mixed anhydrides containing residues of aspartic acid, leucine, tyrosine, they may be thus transformed into amides, which approximate more and more to the colloids formed by living organisms.

Crystallographic Observations on a Variety of Natural Blende.—P. Hautefeuille.—Not suitable for abstraction.

Researches on the Absorption-Spectrum of the Earth's Atmosphere, at the Observatory of Paris.—N. Egoroff.—During eleven nights, from 8 to 10 p.m., and in different kinds of weather, the author has studied the absorption-spectrum of the atmospheric stratum between Mont-Valérien and the Observatory, the spectrum being produced by a very intense electric light, concentrated and directed by a Mangin projector. On November 3rd and 5th, during rain, with temperatures of 10·9° and 13·8°, all the rays marked in Angström's Atlas were distinctly visible. Twelve lines of the group B were easily distinguished, and those of the neighbouring part of the group *a*. The lines D and D_2 were more feeble than in drier weather. May not these be telluric lines, depending on absorption by the vapour of sodium? It would be desirable in further researches to compare the absorption-spectrum of the earth's atmosphere with the emission-spectrum of the air, as well as to examine if changes in the spectrum would be produced during storms. It is probable that besides watery vapour, air is the only strongly absorbent body. The author proposes to continue his observations between Oranienburg and Cronstadt so as to have an absorption-spectrum freed from the vapour of water.

Electrolysis of Water.—D. Tommasi.—The author shows here that if one of the two electrodes of the voltameter is of aluminium, zinc, or carbon, the decomposition of the water takes place equally.

Reversibility of the Electro-chemical Method for the Determination of Equipotential or Efflux Network.—A. Guébhard.—Not susceptible of useful abstraction.

Magnetic Properties of the Nickel-iron of Santa Caterina, Brazil.—H. Becquerel.—This iron is much less magnetic than pure iron. If heated for an hour to bright redness in lime, to avoid too great oxidation, and then slowly cooled, the ingot became twenty times more magnetic than in its natural state, and almost equal to iron.

Proportions of Carbonic Acid in the Higher Regions of the Atmosphere.—A. Muntz and E. Aubin.—Specimens of air taken at the summit of the Pic de Midi gave results extremely similar to those previously obtained in the plain of Vincennes.

Moniteur Scientifique, Quesneville.
September, 1881.

Studies on the Alkaloids.—Dr. W. Kœnigs.—The first part of an extensive memoir, in which the author, after a historical introduction, treats of the mutual relations of these bodies, their behaviour with acids and alkalies, their oxidation, and the relation between the alkaloids and the pyridic bases. He then gives an account of quinoline and lepidine, the behaviour of the former with reducing agents, its nitro- and amido-derivatives, the oxidation of quinoline and lepidine, the pyridinocarboxylic acids and bases, and piperidine.

A New Class of Colouring-Matters Discovered by H. Kœchlin and O. N. Witt.—The colours in question are blues and violets, remarkable for their cheapness and fastness; they have received the name of indophenols, and have been patented by the inventors. They are applied in dyeing in a manner approaching that in use for indigo. Thus, in order to dye wool the colouring-matter is stirred up in alkaline water and heated to 80° with grape sugar. The liquid becomes greenish with bronze striæ and reflections on the surface. It is then diluted with much hot water, and the wool is entered. When the shade has been reached it is taken out, drained by pressure between rollers, washed in abundance of water, and the colour is developed by exposure to the air or better by a passage through an oxidising bath. For printing the colour is thickened with white starch, [illegible] soda is added, and a reducing [illegible] which have won for Mitchell's "Manual" hydrosulphite. It is then printed upon cloth which has been prepared in sulpholeate of ammonia and steamed for one and a half to two hours. In this manner indophenol blue can be associated with alizarin reds, aniline blacks, &c., and all steam colours. Prof. Noelting considers that these colours will prove more dangerous rivals to indigo than the artificial indigo of Baeyer.

Review of Chemical Researches Published in Germany.—A collection of extracts from the *Berlin Berichte*, from the *Journal für Prakt. Chemie*, and the *Annalen*.

Radiophony.—W. H. Preece.—A translation from *Engineering*.

The Magnesia Industry.—T. Schlœsing.—Already noticed.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, September 15, 1881.

A certain M. Paul Carrière, resident in New York, is said to have invented a heat-accumulator, or "thermophere," of such power that a box of 5 centimetres cube will serve to warm a house during a long winter. The editor of *Les Mondes* quotes the old proverb "A beau mentir qui vient de loin."

Position of the Carbons in Electric Arc Lamps.—M. Duboscq.—The author recommends that the two carbons should not be placed exactly in the same straight line, but that the negative should be a little in front of the positive. Otherwise the positive carbon is formed into a depression, at the bottom of which, and masked by its edges, is found the most intense light.

On Ammonium Bicarbonate.—M. Melsens.—This salt is almost fixed in ordinary air, but is easily dissociated if moistened with a little water.

On Cathodes and Phosphorescent Light.—M. Goldstein.—In this memoir, which is continued from the last number, the author seeks to prove the improbability of a convective discharge in spaces filled with rarefied gases. He ascribes the relative darkness of the space near the cathode to the small number of the luminous particles of the electrodes, and not, as does Mr. Crookes, to the want of collision of the radiating matter with the particles of the gas.

MEETINGS FOR THE WEEK

Saturday, 10th.—Physical, 3.
Monday, Dec. 12th.—Medical, 8.30.
— Society of Arts, 8. "Some of the Industrial Uses of the Calcium Compounds," by Thos. Bolas, F.C.S.
— London Institution, 5.
Tuesday, 13th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
Wednesday, 14th.—Society of Arts, 8. "Electric Lighting at the Paris Electrical Exhibition," by W. H. Preece, F.R.S.
— Microscopical, 8.
— Society of Public Analysts, 8. "Some Observations on the Permanganate Test," by Dr. Dupré, F.R.S. "A New Method of Testing for Alum," by A. Wynter Blyth, M.R.C.S.
Thursday, 15th.—Chemical, 8.
— Royal, 4.30.
— Philosophical Club, 6.30.
— London Institution, 7.
— Society of Arts, 8. Adjourned Discussion on the Patent Bill prepared by the Society of Arts.

THE CHEMICAL NEWS.

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...which are theoretically supposed to be.

ITS FIRE RISKS AND THEIR REMEDIES.

By HENRY MORTON, Ph.D.
President of the Stevens Institute of Technology.

Some very lamentable accidents have strongly directed public attention to the question of danger possibly accruing to life and property through the rapidly increasing employment of electricity as a source of light, and as the actual conditions of this danger, like the true properties of the agency from which it may arise, are but little known, a brief explanation of some simple facts related to this subject will be at this time seasonable and perhaps useful.

I would propose, then, to treat this subject under two general heads, namely:—1st. The sources of danger; 2nd. The conditions of their prevention, or of security.

The sources of danger in the use of the electric light are essentially two: from the conducting wires and from the electric lamps.

As long as the electric fluid, or electric energy, is conveyed by a sufficiently good conductor it is perfectly harmless, resembling a river flowing in its natural channel, and powerless to rise above its banks: it is only when some easier channel into surrounding objects is offered or some partial obstruction of a certain character impedes its regular flow that trouble may arise.

The conditions of these difficulties are, moreover, very peculiar.

Thus, for example, if two electric conducting wires, forming the outgoing and returning paths of a powerful current, are placed near each other, but are separated by a bad conductor,—as, for example, when both are tacked on to a board partition wall—the current will follow the wire from end to end, with no development of heat in the same, or tendency to leave the conductor or pass into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a small wire, some metallic dust, or a film of water containing mineral matter in solution, then a portion of the current will be diverted into this "short-cut" from wire to wire and may heat the fine wire, or the metallic dust, or the wood wetted with the aqueous solution, so as to cause the ignition of inflammable matter.

Accidents of this nature have already occurred. Thus, a telegraph or telephone wire having fallen across one or more of the conductors used for street-lighting purposes has been fused, or, itself escaping, has caused the fusion of finer wires connected with it.

Again, two wires, being the outgoing and return circuits of a powerful current, have been nailed side by side, without other insulation, on the same board of a floor, partition, or ceiling; and though used safely for a long time, while the woodwork was in its normal state, have developed a very dangerous activity when the wood between them was wet with dirty or impure water. In that case the water offers a circuit through which a cross current is established, which first heats the damp wood, then chars it, and finally establishes a series of minute arcs or electric sparks along this charred surface, which would soon develop a conflagration if left uncorrected.

Again, two such wires as above, insecurely attached near each other, may be brought into momentary contact and then separated, in which case an electric arc, with its intense light and heat, will be established between them. In like manner a conducting wire itself may be insecurely connected at some point, and if the abutting ends are separated slightly during use, a similar "arc" with its intense heat may be there developed.

These examples will give a fair idea of the dangers arising from the conducting wires, and they are manifestly to be guarded against by a proper separation and insulation of the wires themselves. Of this, however, more anon. At present I would only further point out that there is no risk whatever of any heating or other injurious action arising in or from the conductor itself when an adequate one is used, as must be the case from motives of economy; since an inadequate conductor would involve ruinous expense in the use of the electric current.

Electricity is not to be regarded as a sort of fluid fire passing along the conductor; and some popular notions on this head are as absurd as were similar ones which prevailed in reference to illuminating gas at the time of its first introduction, and which caused rules to be made in some places that no gas-pipe should be allowed to come in contact with any wood-work.

Turning next to the dangers which might be expected from the electric lamp, it is to be remarked in the first place that these in the case of the arc lights depend much upon the number of lamps operated on the same circuit. Thus, if thirty or forty lamps are operated in series, the electromotive force of the current must be sufficient to maintain a correspoding number of arcs; and, therefore, if by any means many of these arcs are closed out the electromotive force of the current available for the remaining ones would be so excessive that their arcs might become excessively long, and even the metallic carbon holders and other parts of the lamps constitute poles between which the arc would spring, melting the metal work and establishing a very dangerous centre of combustion.

To avoid this class of dangers two provisions should be made.

In the first place some arrangement in the lamp itself by which, whenever the arc exceeds certain safe limits, the current will be automatically diverted from it and carried through a good and sufficient conductor; and, in the second place, some apparatus in connection with the electric generating machine by which the electromotive force of its current should be varied automatically in correspondence with the resistance of the circuit, so that any diminution of such resistance, as by the closing out of several arcs, should cause a corresponding diminution in the force of the current generated.

Numerous contrivances for both of these purposes have been already carried to greater or less perfection and efficiency, and it is manifestly possible by such means to secure immunity from risks of this sort.

The securing of adequate insulation for the conducting wires in view of the endless ramifications of telegraphic and telephonic systems, to say nothing of the other conductors found in all buildings, is a problem of no small difficulty. One important general principle would seem to be the equal insulation of the return as well as of the outgoing wires, as well as of the machines, and the avoidance of all ground connection for any part of the circuit. Another general rule would be the separation of outgoing and return wires as far as possible from each other; and yet another, the continuous insulation of conductors, leaving no vulnerable places even where danger would not directly result from accidental contact.

Fully to discuss all the details of this subject would be impossible within the proper limits of such a note as the present, and I will therefore only say in conclusion that, with well matured plans and skilful and intelligent provision, all these dangers may be provided against, and electric lighting may be made as safe as that obtained by gas or by candles; but without such care and judgment the use of electricity on the grand scale, either for lighting or for transmission of power, would involve serious additions to the risks which accompany so many of the conveniences which constitute a large factor of our modern civilisation.

What I have here written is but a fragment of the entire subject involved, and at some future time I hope to fill out and complete this preliminary sketch.

METHYL-ORANGE AS AN INDICATOR IN ALKALIMETRY.

By Professor G. LUNGE.

Many enquiries having been addressed to me from time to time concerning the use of "Tropæoline," &c., in alkalimetry, I think it will be convenient to explain this matter in your columns.

Some time ago Dr. W. von Miller recommended the use of Dr. O. N. Witt's Tropæoline O O as an indicator, and pointed out that it is indifferent to CO_2, so that alkaline carbonates can be titrated with it in the cold. Shortly after I drew attention to the fact that several other azo compounds are far more sensitive than the above, and I especially recommended one which was at that time best known as Poirrier's Orange, No. III. The same has also been sold as "Helianthine" and as "Tropæoline D." It is in reality a salt of sulpho-benzene-azo-dimethylamin, for which long name I propose the short and sufficiently clear name "Methyl-orange." This compound imparts a yellow colour to alkaline solutions, and turns pink with the slightest excess of a strong acid: the transition is more delicate and sudden than with any other compound I have tried. It has, moreover, the advantage that it is indifferent, not merely to CO_2, but also to H_2S and acetic acid, so that it can be employed, among other purposes, for titrating black-ash solutions in the cold. Only mineral acids can be employed as standard liquors in this case: oxalic acid (the same as the other vegetable acids and sulphurous acid) gives an irregular and less accentuated transition of colour. Sodium thiosulphate behaves like a salt of the strong mineral acids. Nobody who has once or twice tried methyl-orange *in the proper way* ever reverts to the use of litmus, which involves boiling the liquid and spending three or four times as much time over the test, and for several years past the former has been employed almost exclusively, both in my own and in my colleague's (Victor Meyer's) laboratory.

But a difficulty has arisen in this way. Several persons have tried other tropæolines,—have not found them to answer, or they have even tried methyl-orange, but not in the proper way, to be described below. It has also been very difficult to procure the latter; for just owing to its extreme sensitiveness in the presence of traces of mineral acid it is not a good dye, and its manufacture as such had ceased. But as I found it to be such an excellent indicator, and that many people enquired after it, I induced a Swiss colour works to manufacture it on purpose. Dr. T. Schuchardt, of Goerlitz, has undertaken the retail sale, and Messrs. Mawson and Swan, of Newcastle-upon-Tyne, will supply it to British customers. Since only a minute quantity of it must be taken for each test, it is actually much cheaper than litmus, a few grammes lasting a lifetime.

Methyl-orange is employed in a very dilute aqueous solution, of which only so much should be added to the liquid to be tested, say with the point of a glass rod, that an extremely faint yellow colour is produced. There should be sufficient to show a decided pink with an excess of acid; but if the alkaline liquid be strongly yellow, the transition from this to pink is only gradual, and no sharp results can be obtained. The transition from pink to a faint yellow, in titrating acids by means of standard alkali, is equally sharp; and a solution of sodium carbonate is just as good for this purpose as one of caustic soda, the CO_2 making absolutely no difference. The test must be made at the ordinary temperature, or near the same; with warm liquids the results are unequal and erroneous.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending November 30th, 1881.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

December 7th, 1881.

Sir,—In the following tables you will find recorded the results of our analyses of the 182 samples of water, collected by us during the month of November on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, one was recorded as "slightly turbid," and 5 as "very slightly turbid." The remaining 176 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from November 1st to November 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright,

Of the 26 samples from the mains of the Chelsea Water Company, the whole, excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, one was recorded as "slightly turbid," and one as "very slightly turbid." The remainder were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole, excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

These results show that the quality of the water supplied by the London companies continues to be excellent, notwithstanding the unfavourable condition of the rivers consequent on the heavy rainfall of the month. The aëration of the water is abundant, and its freedom from organic matter but little less complete than during the summer months.

We have the honour to remain, Sir,
Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

AN APPARATUS FOR THE RAPID ANALYSIS OF MIXTURES OF GASES.

By ARTHUR H. ELLIOTT, Ph.B., F.C.S.,
School of Mines, Columbia Coll., N.Y.

In gas-works, and also in many iron- and steel-works, it often becomes necessary to make a number of analyses of mixtures of gases daily, which, of course, is only possible with simple apparatus. The earliest and simplest form of apparatus was a tube for the determination of carbonic acid, very much like an inverted burette, used by C. Stammer.* This tube was further modified by F. M. Raoult,† who used two stopcocks, one above and another below; and to the upper stopcock was attached a funnel, which serves to introduce the chemicals in solution for treating the gas. After treating the gas, Raoult washed out the chemical used with water, introduced through the funnel, and the gas was measured by bringing the tube to a nearly horizontal position and allowing water to run in through the funnel.

Wilkinson modified this tube of Raoult by placing it in a wider tube having a stopcock below, and omitting the stopcock upon the lower end of the measuring tube. By this means he could adjust the pressure upon the gas by adding water to or drawing it from the exterior tube.

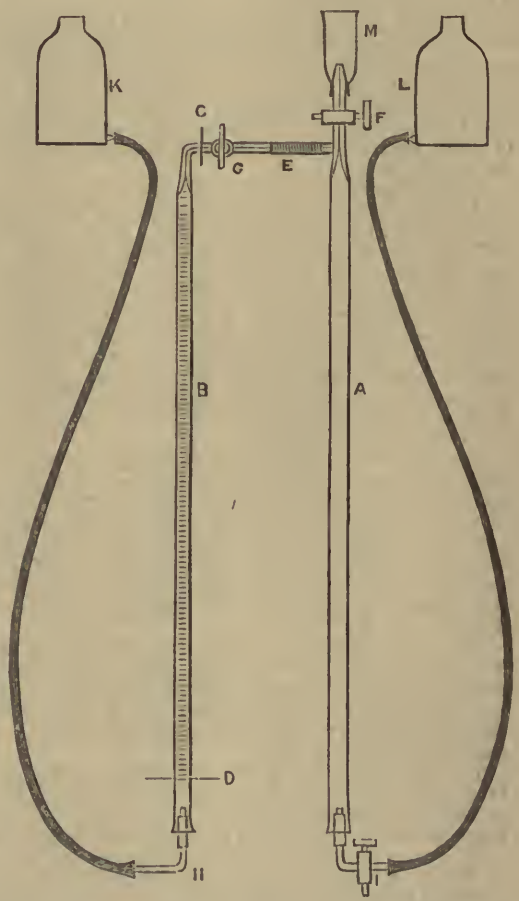
But the difficulty with these methods is the necessity of washing out the chemicals used to absorb the various gases. For example, after treating a gas mixture with pyrogallate of potassium, it is necessary to wash out all the pyrogallate before adding bromine to absorb the illuminants, otherwise the bromine is absorbed by the alkali before it can act upon the gas. To obviate this difficulty, and one or two others, I have used the apparatus described further on.

The apparatus of Orsat at once suggests itself as a remedy for these difficulties; but, unfortunately, to attain the same accuracy as with the apparatus I describe, you have to use four times the amount of time, and moreover the apparatus of Orsat is both costly and fragile.

The apparatus is shown in the accompanying drawing. The tube A is of about 125 c.c. capacity, whilst B, although of the same length, holds only 100 c.c. from the mark D, or zero, to the mark on the capillary tube at C, and is carefully graduated into one-tenth c.c. The attachments to these tubes below are seen from the drawing, except that the stopcock I is three-way, with a delivery through its stem. The bottles K and L hold about one pint each. The tubes A and B are connected above with one another, and with the funnel M by capillary tubing, about one m.m. in internal diameter. There is a stopcock at G and another at F, while the funnel M, holding about 60 c.c., is ground to fit over the end of F above. At E is a piece of rubber tubing uniting the ends of the capillary tubes, which are ground off square to make them fit as close as possible.

In beginning the analysis of a mixture of gases, the stem exit of the three-way cock I is closed by turning it so that L and A are connected through the rubber tubing; the stopcocks F and G are opened, and water is allowed to fill the apparatus from the bottles K and L, which have been previously supplied. When the water rises in the funnel M, and all air-bubbles have been forced out of the tubes, the stopcocks F and G are closed, the funnel M removed, and the tube delivering the gas to be tested attached in its place. By now lowering the bottle L slowly, and simultaneously opening the stopcock F, the tube A is nearly filled with gas, and the stopcock F is closed. The tube delivering the gas is now removed, the funnel M replaced, the bottle L raised, the bottle K lowered, and by opening the stopcock G the gas is transferred to the graduated tube B. By placing the bottle L on a stand at about the level of the water in A, the level in B and in the bottle K can be adjusted to the zero point, and the stopcock G is closed. The excess of gas in A is expelled by opening the stopcock F and raising the bottle L. The gas remaining in the capillary tube between C and the vertical part is disregarded, or in very careful work it may be measured and an allowance made in not filling the tube B quite to the zero mark, but usually it is too small to be worth notice.

Having measured the gas to be tested, it is now transferred by means of the bottles K and L into the tube A, and the fluid chemicals added by placing them in the funnel M and allowing them to flow down the sides of the tube slowly, care being taken *never* to let the fluids run below the level of the top of the vertical tube in the funnel. It is best to have a mark on the outside of the funnel at least three-fourths of an inch above the top of the level



of the vertical tube, and never to draw the fluid down below this point.

Having treated the gas with the chemical, it is transferred by means of the bottles to the tube B, to be measured. If the chemical gets into the horizontal capillary tube, the passage of a little water from the bottle K will remove it, before transferring the gas. When the gas residue is in B, and the fluid in A has been adjusted at the mark C on the horizontal tube, the stopcock G is closed, the bottle K is lowered till the level of water in it and that in the tube B are the same, and the reading is then made. The tube A is now filled with the chemical just used and water. By turning the stem of the three-way cock I, so that it communicates with A, and also opening the stopcock F, the contents of the tube can be run out, and water run through the funnel M to clean the tube for a new ab-

* *Dingler's Polytech. Journ.*, cii. 368.
† *Comptes Rendus*, 1876, 844.

sorption. When the tube is clean, by turning the stopcock I, so that A and L communicate, the water is forced into A, and the whole is ready to receive the gas for new treatment. By this means the gas is removed from the action of the water used to wash out the chemicals, and the chemicals are completely removed from any interference with each other when treating a mixture of gases. In using this apparatus the solutions are added in the following order:—

1. *Potassic hydrate*, to absorb carbonic dioxide (also hydrogen sulphide and sulphurous oxide* if present).
2. *Potassium pyrogallate*, to absorb oxygen.
3. *Bromine*, to absorb illuminants, like olefiant gas and acetylene, and after the absorption is complete, and the bromine vapours cause an expansion, a little potassium hydrate is added, to absorb these vapours before the gas is transferred and measured.
4. *Cuprous chloride* in concentrated hydrochloric acid solution, to absorb carbonic oxide. After this absorption is complete the gas is transferred to the measuring-tube, the contents of the tube A run out, the tube washed, and filled with water from the bottle L. The gas is now transferred to A, and treated with potassium hydrate solution, to absorb hydrochloric acid vapours, before the final reading is made in B.

The treatment up to this point takes from twenty to thirty minutes, according to the amount of practice the operator has had with the apparatus. The gas residue still contains marsh gas, hydrogen, and nitrogen. By removing the funnel M, and attaching in its place a rubber tube communicating with an explosion eudiometer in a deep cylinder of water (both eudiometer and rubber tube being drawn full of water), a portion of the gas residue can be mixed with oxygen, exploded, and the contraction and the carbonic acid determined, the marsh gas and hydrogen being calculated by the usual formula. The nitrogen is found by the difference of the addition of the other constituents and one hundred.

The explosion tube is simply a tube like A, without the lower attachment and the lateral capillary tube above, the funnel M being retained, and two platinum wires are fused into the glass near the top, to give the spark for ignition. It is only necessary to clamp this tube down upon a piece of cork in a vessel of water during explosion, and adjust the water-level in a tall cylinder of water when making the readings of contraction and absorption of carbonic dioxide.

The whole analysis can be readily completed in forty-five minutes, and with due care gives results that are practically correct. Analyses done with an Orsat apparatus, with great care, gave results almost identical with those obtained by the above-described apparatus in one-fourth the amount of time.

The great advantage of this apparatus over the single tube method is, that the gas is not submitted to the action of the water used to wash out the chemicals, which I have found to reduce the volume of the illuminants by 2 per cent.

Of course this method will not compare with the methods of Bunsen and others, where very delicate readings and nice precautions are taken, but it gives very good results for rapid work, and answers every purpose in every-day practice in a gas or metallurgical works.

The water used in the apparatus should be of the same temperature as the room in which the analysis is made, and by careful handling little or no chemicals get into the bottle L.

When working in a warm place the tube B should be surrounded with a water-jacket, to prevent change of volume in the gas while under treatment.

Movements of Viscous Liquids.—Dr. Margutes.—By keeping glycerin, castor oil, &c., in regular motion for some time, the author has obtained characteristic figures. —*Les Mondes.*

* If these gases are present in large quantities, special methods are necessary for their estimation.

ON A

NEW METHOD OF DETERMINING THE CHLORATE IN BLEACHING CHLORIDES.

By M. E. DREYFUSS.

THE various methods hitherto proposed for this purpose are very complicated and unfit for industrial purposes. The author's method is based on the property of cupric acid in a strongly hydrochloric solution of being reduced to cuprous oxide by the action of stannous chloride at a boil. The end of the process is indicated by the decolouration of the liquid, which from yellow becomes colourless. For the process are required:—

I. A solution of copper, made by dissolving blue-stone in distilled water so as to make up a litre, of which 10 c.c. represent about 0·1 grm. of metallic copper.

II. An acid solution of stannous chloride, made by dissolving 15 grms. of this body in 200 c.c. of hydrochloric acid and making up to a litre with distilled water.

III. A solution of potassium chlorate; 5·917 grms. of this salt are dissolved in a litre of distilled water; 10 c.c. of this liquid are exactly equal to 0·05 grm. calcium chlorate.

To find the value of the chlorate solution in comparison with that of potassium chlorate 10 c.c. of the solution of copper (0·1 grm. of copper) are poured into a flask or a conical glass of colourless glass, holding 150 c.c., and 50 c.c. of hydrochloric acid are then added. The mixture is heated to an incipient boil and titrated with the stannous liquid till decolourised. To the colourless liquid are added 5 c.c. of the potassium chlorate, which oxidise a corresponding quantity of cuprous chloride. This quantity is determined by titrating again with stannous chloride. By this titration is found the corresponding relation between the cupric and the chlorate solutions. When this relation is once determined it does not vary as long as the solution lasts.

Preparation of the Sample of Chloride of Lime.—10 grms. are stirred up in 100 c.c. of water, and saturated with ammonia, which is added by small quantities till there is a slight excess. It is then boiled till the odour disappears, and the liquid with the precipitate is passed into a flask marked at 500 c.c. The liquid is let settle, depositing a precipitate, which contains a little ferric oxide.

The introduction of a little potassa in the chloride, after it has been saturated with ammonia, much facilitates the settlement of the deposit. The presence of this deposit in the liquid has no very definite effect upon the results. When the solution of the chloride is thus prepared the chlorate is titrated; 10 c.c. of the cupric solution are raised to a boil with 50 c.c. of hydrochloric acid; it is titrated to decolouration with stannous chloride; then 50 c.c. of the solution of the settled solution of chloride are added; it is boiled, and the copper which has been oxidised is titrated again. This determination is applicable also to liquid chlorides.—*Bulletin de la Société Chimique de Paris.*

DETERMINATION OF POTASH IN POTASSIUM SALTS AND IN POTASSIC MANURES.

By M. A. ROUSSELOT.

ACCORDING to the nature of the salt there may have to be determined potash, soda, magnesia, chlorine, sulphuric acid, nitric acid, moisture, insoluble matter, &c. The author treats here merely of potash.

A. Dissolve 10 grms. in water and make up to a litre. Take, according to the nature of the salt, 125 or 250 c.c., and introduce into a half-litre flask. Boil for a few

moments, and add 20 c.c. baryta-water at 1-20th in case of a chloride, or 50 c.c. if a sulphate. Pass in a current of carbonic acid, boil for half an hour, let settle for some hours, filter into a flask marked at 500 c.c., and make up this volume with the washing-waters.

B. Take in duplicate 200 c.c. if a sulphate, or 100 c.c. for any other salt; put the portions into two porcelain capsules of 10 centimetres in diameter, add hydrochloric acid, and then 40 c.c. = 2 grms. platinic chloride at 1-20th. Evaporate to dryness in the water-bath, and take up in alcohol at 60° mixed with 1-10th ether; wash by decantation with the same liquid, so as to have about 200 c.c. of filtrate.

C. Put the filter and its contents into a ¼ litre flask, pour upon it boiling water in small quantities by means of a washing-bottle until the platinum salt is completely dissolved. Heat in a large porcelain capsule (16 to 18 centimetres in diameter) about ½ litre of distilled water, and add 20 c.c. = 2 grms. sodium formiate (solution at 1-10th), and heat to a boil. Pour then into the capsule the solution, likewise boiling, of the potassium chloro-platinate. Keep up the ebullition for a quarter of an hour, and until all escape of gas has ceased. When the liquid is clear and quite cold, filter, wash the precipitate with hot water acidulated with hydrochloric acid, and pour it finally upon the filter. Clean the sides of the capsule with a glass rod tipped with a small caoutchouc stopper, still using the acidulated water, and finally finish washing the filter with hot distilled water. The filter and its contents are dried, calcined in a small tared platinum capsule, and weighed. The net weight found after deduction of the ash of the filter is multiplied by 200 × 0·4747. We have thus at once the percentage proportion of KO in the salt analysed. This method, though somewhat long, totally eliminates the excess of barytic salt, and furnishes very accurate results.

For the determination of potash in manures the author takes 10 grms. After having ground it up in a mortar, and exhausted it completely with boiling water, he filters, and makes the solution up to 1 litre. He then operates upon quantities of the liquid corresponding to 1·25 to 5 grms. of the manure, and treats with baryta-water. Then, after a long boiling, at least half an hour, to expel ammonia and eliminate phosphoric and sulphuric acids, a current of carbonic acid is passed into it for half an hour. After boiling, to decompose the bicarbonates, it is let settle, and the analysis is completed by filtering as in the former case.—*Bulletin de la Société Chimique de Paris.*

METHOD FOR ACCURATE AND RAPID ANALYSES OF AIR.

By E. W. MORLEY, M.D., Ph.D.,
Hurlbut Professor of Chemistry in Western Reserve College.

I HAVE made a series of daily analyses in duplicate of air collected at this place for six months beginning with January 1, 1880, and one for six months and twenty days beginning October 1, 1880. The samples of air were collected in bottles with well fitting glass stoppers. A few drops of solution of potassium hydrate being put into the bottle, this was set in the open air, and the air in the bottle displaced by sufficient aspiration, the observer keeping at a little distance to the leeward side. The stopper was then put in place and wet with the potassium hydrate by inverting the bottle and turning the stopper. Experiment showed that it was possible to keep samples for many days in this way with the certainty that they remained unchanged.

A mercury pump was used to withdraw the sample from the bottle. A rubber stopper was used to make the needed connection with the pump. Experiment showed that this rubber in contact with the alkaline solution does not absorb more than a hundredth per cent of oxygen from the air in the bottle in twenty times the period during which it was in contact with the air used in the analysis. The pump discharged the air into a jar standing over mercury in the laboratory trough of the apparatus for analysis.

This jar being lowered, together with the cistern, over the recurved capillary end of the eudiometer tube, a certain quantity of air was taken into this tube. This quantity was measured approximately by using a journeyman pressure tube having a small bore. The quantity used was almost always the same, and occupied from 470 to 475 millimetres in length of the eudiometer tube, when the pressure on it was that of a column of mercury of this same length.

This quantity was then measured accurately with the standard pressure tube. This had a Jolly point in the vacuum at the level of the zero of the graduation on the eudiometer tube, which zero was at the top of the tube. The level of the mercury in the standard pressure tube being never permitted to vary more than a fraction of a millimetre, its vacuum was found to remain constant and unimpaired. When the mercury in it had been put in connection with the mercury in the eudiometer, and its upper level had been brought to the Jolly point by the use of a fine adjustment, the level of the mercury in the eudiometer was read with a microscope magnifying fifty diameters, and provided with an eye-piece micrometer. By this arrangement, when everything was prepared, it was possible to verify the contact at the Jolly point, to read the thermometer to the hundredth of a degree, and to read the level of the mercury in the eudiometer, in less than ten seconds. Uncertainty as to the actual temperature at the instant of final reading was in this way mostly avoided. This reading microscope is carried on a vertical cylinder which is solidly attached to the firm iron tripod which supports the whole apparatus. On this cylinder the mounting of the microscope can be clamped at the required height. The microscope is then made to give distinct vision of the graduation on the surface of the eudiometer. This graduation consists of lines not more than the eight-thousandth of an inch wide, cut with a diamond. No errors exist amounting to the hundredth of a millimetre in the parts of the graduation which have been used in these analyses. When distinct vision is obtained of the graduation, a fine adjustment moves the microscope vertically till the terminal lines of the eye-piece micrometer coincide with two lines of the graduation on the eudiometer. If now the horizontal focussing movement carries the microscope forward about half an inch towards the eudiometer, the microscope will give distinct vision of the meniscus in the tube, and its level can be read by the divisions of the eye-piece micrometer, which represent the divisions on the surface of the tube carried forward optically into its interior. It would be easy to show how far the use of such an arrangement is superior to that of a cathetometer for the purpose in hand, in accuracy, in rapidity, and in simplicity of reduction for expansion of the scale.

The measured quantity of air was next transferred to a jar standing over mercury in the laboratory trough.

A quantity of hydrogen amounting to about sixty-three per cent of the air taken was next measured approximately, and added to the air in the jar. This amount was always the same, so that any errors which were a function of the quantity of hydrogen should be constant in amount, and should not therefore affect the *differences* of the analyses. Sixty-three per cent was used in order that the last and first readings of volume might be made with the same position of the reading microscope.

After the air and hydrogen had had time thoroughly to mix, they were transferred back to the eudiometer, measured, expanded, exploded, and again measured. The expansion was always the same. In the transfers mentioned there is absolutely no possibility of loss or of admixture by leakage except by gross carelessness. The only place where leakage could take place is the stop-cock at

the top of the eudiometer. This stop-cock was specially made for this place, and has not yet been found to leak, though it has been tested for ten minutes against an internal vacuum before or after each analysis.

Two coincident readings were obtained for each measurement, though the result was always calculated from the last reading. To secure accurate determinations of temperature, the eudiometer and pressure tubes are enclosed in a box with plate-glass front and back, containing about ten litres of distilled water. This is vigorously stirred, except at the instant of reading the microscope, by means of a current of air from a condensing pump driven by power. I have had no difficulty in getting the required two coincident readings in half a minute when the thermometer was rising; but when the thermometer is falling, the difficulty in getting a reading of the thermometer which shall really represent the temperature is enough to make work very vexatious, for an error of a hundredth of a degree in the difference of temperature at two measurements in the same analysis is close upon the limit of allowance.

Great care has been taken to obtain hydrogen of sufficient purity. In the early analyses, a Bunsen's decomposing cell of the common form was used. It then often happened that the analysis made with the first hydrogen obtained after an interval of rest would give results showing a deficiency of oxygen of about a hundredth of one per cent. Often analyses had to be rejected, until the cell was freed from compounds of hydrogen with zinc or carbon, which had been produced by local action at the surface of the zinc. Finally, a cell was constructed which could be every morning connected with the air-pump and exhausted of hydrogen, so as to remove these compounds of hydrogen with zinc or carbon, whether they had risen through the liquid, or were still adherent to the zinc plate or dissolved in the dilute acid. The cell had a mercury stop-cock which interposed a barometric column against the leakage of air into the cell; but for additional security, the hydrogen coming from it passed through several inches of active platinum black. In this way I have now secured a supply of hydrogen which probably never occasions a difference of a five-hundredth of one per cent in two analyses of the same sample. Experiment shows that hydrogen may safely be left standing over mercury in a *clean* bell glass for a long time. I have left two samples for eleven weeks, which samples then were used in a duplicate analysis of a sample of air against a duplicate analysis of the same sample made with two samples of hydrogen just from the decomposing cell. Hydrogen was therefore sometimes used which had stood for a few days. Duplicate analyses were always made with different samples of hydrogen.

It may be observed that the corresponding measurements of different analyses were made under identical conditions. The calibration error, and the error caused by the imperfect parallelism of the reading microscope in its different positions, therefore, disappear from the *differences* of the analyses of different samples. The same is true of the error caused by the production of water in the eudiometer between the second and third measurements in each analysis. No correction has been applied for this error, because the distribution of the water above and below the meniscus cannot be easily determined. The amount of water adhering to the interior of the eudiometer before the commencement of an analysis has also been made always approximately the same. This has been accomplished by producing a vacuum in the eudiometer after the analysis, and the letting the mercury rise in it with a determinate velocity; when the eudiometer is clean, considerable uniformity is thus obtained.

In making observation as accurate as is required for my purpose, it is very important to keep the interior of the eudiometer very clean. A little irregularity in the film of water through which the meniscus is seen will spoil the reading. My eudiometer tube is cemented into a brass fitting which rests in a seat ground for it in the bottom of the enveloping box mentioned before. The eudiometer can be disconnected, removed, washed with castic potash and shot, rinsed out with dust free distilled water, and replaced ready for analysis, in an hour. The accurate fitting of the ground seat makes it possible to restore the zero of the graduation on the tube to the same level within the two hundredth of a millimetre, without even the bestowal of any thought on the matter. With this facility, the eudiometer has been kept sufficiently clean for accurate reading.

It is of course possible that the mean of all my analyses with the new apparatus is affected with a measurable constant error, though no measurable error has yet been traced to any assignable source. But it is certain that the differences in the means for different periods are affected with but very small errors. During the most favourable conditions under which I have used the apparatus, taking seventy minutes for each pair of analyses of the same sample, the mean error of a single analysis was, for half a month, less than the thousandth part of one per cent. Having commonly to work at odd times, and more rapidly than this, the accuracy attained has been less; but, for the whole seven hundred and eighty eight analyses made with it, the mean error of a single analysis has been less than the two hundred and eightieth of one per cent. If, then, two samples of air differ by one-fiftieth of one per cent in their contents of oxygen, the fact of a difference can be detected with a degree of probability nearly approaching certainty, at an expenditure of time not exceeding one hour for each sample. — *American Chemical Journal.*

CHEMICAL METHODS FOR ANALYSING RAIL-STEEL.*

By MAGNUS TROILIUS, Chemist to C. P. Sandberg, London.

Introduction.—By C. P. Sandberg.

Since the discussion on steel rails in America has forcibly drawn attention to the value of chemical analysis, if not as a necessary stipulation, at least as a guide to control the usual mechanical tests, some doubt has been thrown upon the accuracy of the analytical results obtained by different chemists.

To any one having the least acquaintance with chemistry it is quite clear that if exactly similar results are to be obtained from the same borings of steel, exactly the same methods must be used hy the different analysts. Hence the necessity (if complications are to be avoided) of establishing what I may call standard or normal methods, to be used both by the inspectors and chemists at the works. Remembering that the application of chemistry to steel rail inspection is yet in its infancy, it is of great importance to possess a perfect acquaintance with the best methods in use.

Being myself a grateful pupil of Professor Eggertz, of the School of Mines in Sweden, it occurred to me, two years ago, that I could not do better than start a laboratory of my own, and engaged one of his pupils, Mr. Troilius, for the purpose of analysing the steel borings from mechanically-tested rails, so that I might thus obtain, without delay, thoroughly accurate determinations.

Moreover, in order to carry on the operations in perfect accordance with the methods used at the steel works in England and Germany, where I had to control the manufacture, I deemed it desirable to allow Mr. Troilius to go through a course of training at these works; and I gladly seize this opportunity of expressing my grateful acknowledgments to several works in England and in Germany for affording every facility for such an exchange of

* Read before the American Institute of Mining Engineers October, 1881. From the *Journal of the Franklin Institute.*

information as was found necessary to arrive at the best analytical methods to be used.

The value of this preliminary training has already become evident, for, after working a year in my own laboratory, we find that the results hardly ever differ from those obtained at the works; or, at any rate, they rarely differ from the results of those professional chemists who check the same borings in case of any discrepancy.

Inasmuch as this work is principally executed for America, it naturally follows that if it is checked by American chemists it will be of interest, both for them and for the chemists on this side of the Atlantic, to know the methods of analysis followed in the two countries. With this view, I beg to introduce the following paper, which has been very carefully worked out by Mr. Troilius, and therefore deserves the attention of the members of the Institute.

I can only say of this paper, as I have said in my own, "On the Specification and Inspection of Steel Rails in Europe," that it fully explains the methods, which I have hitherto adopted, with excellent results. But if any better methods can be suggested by American chemists, I shall only be too glad to modify my present mode of working.

It only remains for me to add that Mr. Troilius will have great pleasure in answering any remarks or questions that may be addressed to him with reference to the following methods for the application of chemistry to steel rail inspection.

19, Great George Street, Westminster, August, 1881.

Chemical Methods for Analysing Rail Steel.

Useful Appliances.—One of the most useful and necessary appliances in a steel rail laboratory is the hot-plate. An iron plate, 12" × 18" × ⅜" thick, heated from below by a good Bunsen burner, will answer very well; or, if more convenient, the plate may be combined with a coke fire and a muffle-furnace, the coke fire thus heating both the plate and the muffle furnace. In any case, the plate should be heated in such a manner as to have a boiling temperature at only one part, from which part the heat should gradually decrease towards the edges. Thus arranged, the plate forms a very satisfactory substitute for water-baths, drying-boxes, &c., as will be seen in the following description of the methods. There is no risk of destroying beakers, &c., after sufficient experience in working the plate has been acquired.

A plate of this kind has been in use in the London School of Mines for about fifteen years, but, as far as I am informed, it was Mr. Snelus who first employed a plate in this way at Dowlais, and it has since become universally used in English and Welsh laboratories. I should also mention that it has been successfully introduced in the Stockholm School of Mines, in accordance with my suggestion last year in the *Jernkontorets Annaler*. In German steel laboratories the water-bath and other more "scientific" appliances are more generally in use than in England and Wales; in fact, I have not so far seen the plate used in any of the German steel works which I have visited. It is necessary to have the plate placed under a good draught, so as to remove all the noxious fumes which are evolved during the operations conducted on the plate.

As regards other useful appliances belonging to a well-fitted steel laboratory, they are all more or less common or are only occasionally used, and do not deserve as much attention as the above-named plate. Fluted funnels, however, are worthy of being mentioned as being somewhat quicker to work with than ordinary plain ones. I have not found them in use on the Continent as frequently as in the United Kingdom, but they are now beginning to be somewhat more appreciated, even in the Continental countries.

Carbon Determination.—Eggertz's colour-test is a very accurate method for determining carbon in rail-steel, provided the operator has sufficient experience and takes all the necessary precautions. At the same time, this method has the great advantage of being very rapid. It is now nearly twenty years since this method was described in Sweden and Germany by Professor Eggertz, and very shortly afterwards Mr. C. P. Sandberg published an English translation of the method in the Chemical News. In Great Britain the colour-test is now very largely used, every blow in the Bessemer converter being thus tested for carbon, and in the hands of skilled manipulators it gives every satisfaction. In German steel laboratories the colour-test is not so much used as in Great Britain, and costly arrangements are often employed for carrying out determinations of carbon by the combustion process on a large scale. For the daily control of rail-steel, however, this is rather an impracticable arrangement, when results, accurate within 0·01 per cent, can so rapidly be obtained by the colour-test.

Experience soon taught the manipulators at steel-works to modify the method in many respects so as to attain greater rapidity, thus deviating from the directions given by Professor Eggertz in 1862. There has, however, been some uncertainty as to many of the details, and as some rather serious discrepancies have occasionally occurred, especially in analysing the harder classes of steel, there have not been wanting people denouncing the whole method. It is, therefore, with great pleasure that I am able to accompany this paper with a translation of Professor Eggertz's recent article on the subject. As the contents of this article, or at least the more important points, were kindly communicated to me some weeks before it was published in Sweden, I have had ample opportunity of applying the experience thus gained, and have found it thoroughly corroborated by my own results.

The most important facts in Professor Eggertz's paper are contained in the rules given for (1) quantity of acid required for each 0·1 grm. of steels of different percentages of carbon, and (2) minimum addition of water required for each 0·1 grm. of steel dissolved in nitric acid to remove the iron colour.

Referring to the complete* translation, for further information I will now explain how I carry out my determinations of carbon in rail-steel by means of the colour-test. My mode of manipulation is the same as that used at most English and Welsh steel works, with the modifications of the two above-mentioned new rules of Professor Eggertz.

I use 0·2 grm. of the steel for testing, and along with every set of samples 0·2 grm. of standard steel is dissolved. This is indispensable with the mode of procedure I adopt, no precautions being taken to exclude the sunlight, &c. The solution is effected in test-tubes 6 inches long, and about 5-8th inch internal diameter. The dimensions of the test-tubes are not a matter of great importance, but they should not be too narrow.

The nitric acid I always allow to flow into the tubes from a graduated burette, this being by far the best way of adding the acid. The tubes are then put into a beaker 4 to 5 inches high, half filled with water. The beaker may be advantageously covered with a perforated tin plate, and the tubes put through the holes, and thus steadied. Heat is then applied, and boiling is continued until the steels are dissolved; this seldom requires more than half an hour, and is greatly promoted by the jumping of the tubes in the boiling water. When the solution is completed the tubes are put into cold water, and the determination of carbon is thereupon carried out by means of the carbon-tubes. The carbon-tubes are generally bought in sets of three tubes, one of which is graduated and the other two not. The tubes in each set are selected carefully so as to be of the greatest possible uniformity as to dimensions and quality of glass; their capacity is 20 c.c.

In my ordinary work I put the standard steel solution into one of the ungraduated tubes, measuring off by aid of

* The accompanying translation contains an addition made after publishing the article in Sweden, and is thus believed to be more complete than any translation which has already appeared in print.—See Appendix.

the graduated tube, and in very particular analyses I use standard steel solutions of different colours in both the ungraduated tubes. This helps the eye to catch faint differences in tint. The solutions for testing are put into the graduated tube.

The differences in the results, which are sometimes obtained when analysing the harder classes of steel by the colour test, are not observed as far as rails are concerned, and I find no difficulty in obtaining accurate results in this case. In fact, as far as my experience goes, the carbon in rails is that element which can be most easily accurately determined, and this by the simple colour test. But even for harder steels a very much greater certainty is now secured by the method described in Prof. Eggertz's latest publication.

It is always desirable, if not necessary, that the standard steel should have a percentage of carbon not differing too widely from the average percentage of carbon in the steels for testing; especially when dealing with *very* soft steels one finds the necessity of having a soft standard.

In working this method for carbon estimation, when the carbon ranges from 0·10 to 0·80 per cent, I have obtained accurate determinations with great rapidity; and this, indeed, is the great value of the method, which is best seen by its application for ascertaining the carbon in every blow, even at the largest steel works in England, where hundreds of charges are made per day. Ordinarily, a boy is trained to do this work, under superintendence of the chief chemist, and consequently the cost of execution is but very small.

The plan of dissolving rapidly, and then cooling the tubes, as just described, was originally employed by Mr. Snelus at Dowlais.

(To be continued.)

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

Saturday, December 10th, 1881.

Prof. W. G. Adams in the Chair.

New Members:—Lieut. C. E. Gladstone, R,N.; Lieut. C. Gauntlett Dicken, R.N.; Mr. Walter George Woolcombe, B.A., F.L.S.; Rev. Professor Sircomb; Mr. Arthur Clayden, M.A.

Professor Adams said that it had been thought advisable to invite the members to view the Smoke Abatement Exhibition now open, and the meeting was adjourned for that purpose, Professor Chandler Roberts acting as guide.

The next meeting of the Society will be held on Jan. 28, 1882.

NOTICES OF BOOKS.

Technisch-Chemischer Jahrbuch. (Technical-Chemical Annual.) Von Dr. Rudolf Biedermann. Berlin: Julius Springer.

This work, which is now making its third yearly appearance, contains a large amount of matter useful to technological chemists. We find, first, a statistical account of the chemical establishments, and the number of persons employed therein, throughout Germany on December 1, 1875. It must be noted that the table includes many departments of industry which, according to English notions, would be placed in different categories. Thus we find here enumerated coal-mines, brick-kilns, limestone quarries, and other establishments where the operations carried on are purely mechanical. It is not edifying to find that upwards of 6000 persons were at that date engaged in manufacturing articles for the adulteration of coffee, or—translating the German literally—in making "coffee surrogates." Next follow a table of the German production of metals, minerals, &c., for the years 1879 and 1880. There is a conspectus of the Patent Laws of different countries, accurate as far as the space will allow. No one can look over this section without feeling that the English law contrasts disadvantageously with those of most other States. Next follow a variety of legal regulations bearing upon manufactures and commerce. The bulk of the work is taken up with notices of recent improvements in the chemical arts, and is illustrated with 162 woodcuts of plant and apparatus.

Chemiker Kalender. (Chemist's Almanac.) Von R. Biedermann. Berlin: Julius Springer.

We have here a very useful pocket companion for the chemical profession. The author commences with a scientific chronology, giving the dates of remarkable discoveries and inventions, the promulgation of important theories, &c. Then follows the almanac properly so-called, in which the days are dedicated, not to the saints of mediæval tradition, but to the discoverers born on them. Thus February 19th is Volta's day, March 28th that of Laplace, April 18th Liebig's, &c. Not a few days, however, are still open, and not a few of the most illustrious men of science have found no place in the list.

The remainder of the work is composed of "auxiliary tables for the laboratory" of a highly varied and comprehensive nature. There are tables of the coinage of the principal nations; of the degree of fineness of the gold and silver alloys used; circumferences and contents of circles, squares, and cubes, square and cube roots, measurement of certain superficies and bodies; the metric system; measures and weights of different States; atomic weight, arrangement of the elements according to the periodic system of Mendelejeff; comparison and conversion of the thermometric scales of Celsius, Reaumur, and Fahrenheit; comparison of the degrees of the mercurial thermometer with those of the air thermometer: correction of thermometric degrees; boiling-points of aqueous solutions; refrigerating mixtures; heat and work, thermic capacity, specific heats of compound bodies, &c. In like manner the author passes through the subjects of expansion, vapour-tension, atmospheric pressure, light, electricity, specific gravity, specific gravity of liquids (including alkalies, acids, and salts), solubilities, the outlines of qualitative analysis (including the reactions of acids and bases), and the qualitative examination of solids in the dry way. Under quantitative analysis we find a table for the calculation of results, multiples of the atomic weights and their logarithms, and some of the more important molecular weights and their logarithms. We come next to volumetric analysis and to spectral analysis, the latter section being from the pen of Prof. H. W. Vogel. Finally, we have special directions for the technical analysis of water, alkali, bleaching-powder, &c., and a condensed list of recent improvements in chemical analysis. It is impossible, however, to form from this brief sketch any adequate idea of the value of the book. The labour of getting together, tabulating, and condensing such a quantity of facts and figures must have been immense. The chemist will, by simply consulting this pocket-book, find information, which it would take him hours to seek up from standard works and from files of journals and transactions. We consider that Dr. Biedermann has amply earned the gratitude of all chemists, and we hope that his work will find corresponding appreciation.

The book is printed in the Latin character, and with very little of that "reformed," semi-phonetic, orthography which has come into fashion in Berlin.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 21, November 21, 1881.

Condition of Archromatism in the Phenomena of Interference.—A. Cornu.—A mathematical paper, not capable of useful abridgment.

Reactions of the Salts of Gallium.—M. Lecoq de Boisbaudran.—Copper sulphide precipitated from an acid hydrochloric solution is free from gallium, but is sensibly charged with it if formed in an acetic or ammoniacal liquid. Manganese and iron sulphides carry down gallium in a notable proportion. Silver sulphide carries down gallium if formed in an ammoniacal liquid. Arsenic sulphide takes down a notable quantity of gallium if produced in an acetic solution, but not in an hydrochloric solution. The precipitation of gallium by ammonia in excess, or ammonium sulphide, is prevented by the previous addition of tartaric acid. But the presence of this acid does not prevent gallium from being carried down by the metallic sulphides. If a neutral solution of gallium alum is left exposed to the cold for some months, there is formed a white deposit, which dissolves but slowly in dilute sulphuric acid, even with the aid of heat. The neutral solutions of the simple sulphate behave like those of alum. Lime and ferric oxide precipitated by potash in presence of salts of gallium, render an appreciable quantity of this metal insoluble. Salts of gallium give, with potassium ferrocyanide, a precipitate insoluble in hydrochloric acid. This reaction is very sensitive, but it is necessary to use very acid solutions containing from a quarter to a third of the concentrated acid. The washing must be effected with dilute hydrochloric acid, as pure water dissolves the precipitate. The reaction is not interfered with by salts of aluminium or by tartaric acid. One part of gallium shows thus after standing for an hour a perceptible turbidity in 175,000 parts of water. If there is present in a liquid little gallium and much ammonium or sodium acetate, gallium sesquioxide is not precipitated on boiling, or only in slight quantity. Barium carbonate completely precipitates gallium sesquioxide in the cold, but the precipitate, if zinc is present, contains an appreciable quantity of this metal. Calcium carbonate is therefore preferable, as it precipitates zinc less rapidly. Gallium sesquioxide is easily and completely precipitated if its hot acid solution is treated first with sodium sulphite (to reduce ferric salts), then with sodium carbonate almost to saturation, and finally with a slight excess of calcium carbonate. The very complex solutions obtained on attacking blende with *aqua regia* may be very advantageously reduced by means of scrap-iron, which is cheaper than zinc, and gives a much purer crude product.

Crystallisation of Cadmium and Zinc Sulphides.—P. Hautefeuille.—In order to obtain prismatic crystals terminating at both extremities with brilliant surfaces, the author places the amorphous sulphide at the bottom of a porcelain crucible of 0·10 metre in height, and fills it up with alumina slightly calcined. The whole is then heated, when the sulphide is deposited in crystals on the surface of the alumina.

Numerical Application of the Theory of Maximum Result of Two Dynamo-Electric Machines Employed in the Conveyance of Energy.—Maurice Lévy.—This paper is not susceptible of useful abstraction.

Lippmann's Method for the Determination of the Ohm.—M. Brillouin.—The use of open circuits does not simplify but complicates theoretical conditions. If in a closed circuit, suitably chosen, we may regard the current as uniform in the whole extent of the wire, even during the variable period, this is not permissible in an open circuit.

Remarks on the Electrolysis of Water.—D. Tommasi.—On decomposing water with a single element, using a copper wire as positive electrode and a platinum wire as negative electrode, the quantity of copper dissolved is greater than the quantity of copper deposited on the negative electrode.

Glycerin Diformine.—P. van Romburgh.—This compound is a colourless neutral liquid, of a taste bitter at first and afterwards acid. It is soluble in alcohol, ether, and chloroform, insoluble in carbon disulphide. Water resolves it into formic acid and glycerin. Its density is 1·304, and is optically inactive.

Certain Spectral Reactions of Alkaloids and Glycosides.—C. Hock.—The author describes the absorption-spectra of digitaline, delphinine, and belladonnine, all of which are characteristic.

Electric Current Produced by Light.—P. Laur.—The author has observed that the Mexican amalgamation process is rendered more active by solar light. This result he finds due to certain electric currents, which he names photo-electric.

Certain New Cases of Phosphorescence in Plants.—L. Crié.—The author has observed phosphorescence in a number of fungi.

Bulletin de la Société Chimique de Paris, Tome 36, Nos. 4 and 5.

Apparatus employed for Disinfection in the Manufacture of Ammonia from the Distillation of Cesspool Liquids at the Works of the Compagnie Urbaine at Arcueil.—Leon Chateau.—The saturation troughs into which the offensive gases pass are hermetically closed, and placed in communication with a ventilator by an underground channel. The working of the ventilator is calculated to produce in the saturators a draught strong enough to occasion a slight decrease of pressure. Between the saturators and the ventilator is a coke-tower, 5 metres in height, in which is a mixture of ferric oxide and calcium sulphate, prepared in a manner analogous to Laming's mixture for purifying coal-gas. At the upper part of a column is a cistern filled with a solution of ferric sulphate, which flows down continually and moistens the coke of the column.

Chlorides of Iron.—Paul Sabatier.—The author has arrived at conclusions similar to those of M. Ditte (*Annales de Physique et de Chemie*, t. 22, p. 551) as regards the chlorides of manganese, calcium, and iron. He publishes his results regarding the latter, which have not been treated of by M. Ditte.

Determination of Potassa in Potassium Salts and in Potassic Manures.—A. Rousselot.—(See page 290.)

A New Method of Determining the Chlorate in Bleaching Chlorides.—E. Dreyfuss.—(See page 290.)

Tungstoborates.—D. Klein.—Not capable of useful abridgment.

Action of Gaseous Hydrochloric Acid upon Isobutylic Anhydride.—S. Œconomides.—The author has obtained by this reaction an oily body, which he is still studying.

An Accessory Product obtained in the Preparation of Isobutylic Acetal.—S. Œconomides.—The product obtained, $C_{10}H_{20}O_2$, is a non-saturated compound.

Action of Amylene Hydrochlorate and of Amylene upon Benzol in Presence of Aluminium Chloride.—J. Essner.—The principal product formed is amyl-benzene, apparently identical with that obtained by MM. Friedel and Crafts from inactive amyl-chloride.

Essence of Resin.—A. Renard.—From the portion distilling between 103° and 106°, the author obtains heptene, C_7H_{12}. In the products going over about 150° he finds three hydrocarbides, $C_{10}H_{16}$ and two $C_{10}H_{18}$. In the fraction from 169° to 173° there are two terebenic carbides, $C_{10}H_{16}$, the one polymerised by sulphuric acid and the other not attacked by it. Two carbides, C_8H_{14} and C_9H_{16}, are found in small quantity in the portion passing over between 106° and 150°.

Preparation of Meta-toluidine.—O. Widman.—The author dissolves nitrised benzylene chloride in alcohol, adds a considerable quantity of hydrochloric acid, cools to 10°, and adds zinc powder, not allowing the temperature to exceed 12°. When all is dissolved, and the mixture is no longer rendered turbid by water, heat is applied and the escape of hydrogen is allowed to continue for two hours.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Heft 4.

New Researches on the Passage of Rain-waters through Arable Soils.—A. Audoynaud and B. Chauzit.—The chief loss of nitrogen is in the form of nitrates. Sulphuric acid is removed in considerable quantity; phosphoric acid only in traces. The loss of potash and sodium chloride is great.

Flocculation of Small Particles and the Physical and Technical Relations of this Phenomenon.—Prof. E. W. Hilgard.—Under the influence of gentle rotatory movement, small particles suspended in water have a tendency to form larger aggregations, which to a certain extent resist disruption. This tendency decreases near the boiling-point, and is opposed by alcohol, ether, and caustic or carbonated alkalies, whilst it is promoted by acids and neutral salts. Violent agitation destroys the flocks. [This principle has long been known to chemists who have studied sewage precipitation.—*Ed.* C. N.]

Influence of Superficial Desiccation of the Soil upon its Hygroscopic and Thermometric Relations.—Prof. E. Wollny.—The evaporation of water and the escape of heat are reduced by superficial drying.

A New Method of Determining the Absorptive Power of the Soil.—R. Zalomanoff.—The author recommends the filtration method. He concludes that the results obtained by agitation in a flask are conclusive; that Liebig's opinion on the identity of drainage-water and ground-water is erroneous, and that compounds existing in solution and separated on passing through pulverised bodies or through capillary tubes assume another molecular condition.

Manurial Garden Experiments.—W. Lauche and Prof. A. Orth.—The highest results were obtained with farmyard manure plus ammonium and potassium sulphates and superphosphate. The crop was the sugar-beet.

Cultivation with Sewage.—H. M. Davy.—Certain experiments made in the old tanks at Gennevilliers.

Determination of the Albumenoids and the Non-Albumenoid Nitrogenous Constituents of Plants.—Prof. E. Schulze and Dr. J. Barbieri.—The author describes the methods of determining the albumenoids by precipitation with copper solution, by heating the extracts with ferric acetate, with lead hydrate along with a little lead acetate, and with lead acetate alone. The nitrogen existing in crystalline products of the decomposition of albumen is effected by the process of Sachsse and Kormann, which depends on the behaviour of nitrous acids with amides and amidic acids. For nitrogen present as ammonia the author recommends Emmerling's method.

Behaviour of the Sugars with Alkaline Solutions of Copper and Mercury.—Prof. Soxhlet, Dr. Meisl, and Dr. Allihn.—The results obtained are given in the form of tables.

MEETINGS FOR THE WEEK.

Monday, Dec. 19th.—Medical, 8.30.
—— London Institution, 5.
Tuesday, 20th.—Institute of Civil Engineers, 8. Anniversary.
—— Pathological, 8.30.
Wednesday, 21st.—Meteorological 7.
—— Geological, 8.
Thursday, 22nd.—Royal, 4.30.
—— London Institution, 7.
Friday, 23rd.—Quekett Microscopical Club, 8.

THE JOURNAL OF SCIENCE
for DECEMBER (Price 1s. 6d.), includes—

Some Results of Gravitation. By Charles Morris.
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The Ethics of Invention. By An Old Technologist.
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THE CHEMICAL NEWS.

Vol. XLIV. No. 1152.

ON THE EFFECT OF THE SPECTRUM ON THE HALOID SALTS OF SILVER, AND ON MIXTURES OF THE SAME.*

By Captain W. DE W. ABNEY, R.E., F.R.S.

The author has investigated the discrepancies which appear in the accounts of the action of the spectrum on the haloids salts of silver as given by various authors, and eliminated some sources of error from the results obtained by them.

He has also shown that in mixtures of the haloids a secondary action takes place, by which, in certain cases, the spectra photographed on them take a totally different form to that which they would take, supposing that the effect of the rays is an integration of the effects on each haloid taken separately.

PRELIMINARY REPORT TO THE SOLAR PHYSICS COMMITTEE ON THE SUN-SPOT OBSERVATIONS MADE AT KENSINGTON.†

By J. NORMAN LOCKYER.

Since the commencement of the observations, in November, 1879, of the most widened lines in sun-spots, about 220 observations have been made: the maps for the first and second hundred observations have been drawn up and the tabulation of the first hundred completed. The reductions are being carried on, and I hope shortly to be able to lay a full report upon the 200 observations before the Committee, but desire, in the meantime, to lay the present preliminary one obtained before it.

The reduction of the first hundred observations, extending from November, 1879, to September, 1880, has yielded the following results:—

1. An immense variation from spot to spot is to be observed between the most widened lines seen in the first hundred observations. Change of quantity or density will not account for this variation. To investigate this point I had the individual observations of lines seen in the spectrum of iron plotted out on strips of paper, and I then tried to arrange them in order, but I could not succeed, for even when the observations were divided into six groups, about half of them were left outstanding.

2. If we consider the lines of any one substance there is as much inversion between these lines as between the lines of any two metals. By term inversion I mean of any three lines A, B, C, that we may get A and B without C, A and C without B, B and C without A, and so on.

3. We have reason to believe, from experiments made here, that most of the lines seen in the spectrum of iron volatilised in the oxy-hydrogen blowpipe flame are amongst the most widened lines.

4. Certain lines of iron have been seen at rest, while other adjacent lines seen in the spectrum of this metal in the same field of view have shown change of wave-length.

5. The spectrum of iron in the solar spectrum is more like that of the arc than that of the spark.

6. The greater part of the lines seen in spots and flames are common to two or more substances with the dispersion employed.

7. The first hundred spot observations being compared with a hundred observations of the spectra of flames, made by Tacchini at Palermo, have shown that there is no iron line in the region *b*-F common to spots and prominences.

In addition to these facts, already communicated to the Committee in more or less detail at different times, the following have been noticed in the continuation of the reductions.

8. The lines of iron, cobalt, chromium, manganese, titanium, calcium, and nickel seen in the spectra of spots and flames are usually coincident with lines in the spectra of other metals, with the dispersion employed, whilst the lines of tungsten, copper, and zinc, seen in spots and storms are not coincident with lines in other spectra.

9. The lines of iron, manganese, zinc, and titanium most frequently seen in spots are different from those most frequently seen in flames, whilst in cobalt, chromium, and calcium the lines seen in spots are the same as those seen in flames.

10. Towards the end of the first series a few lines appeared among the most widened ones which are not represented, so far as is known, among the lines seen in the spectra of terrestrial elements. This change took place when there was a marked increase in the solar activity.

So much for the results from the first series of observations.

The second series began on 29th September, 1880, and comes down to October, 1881. From a partial reduction of the observations the following results have been obtained:—

11. The number of new lines seen amongst the most widened lines has been steadily increasing. Many of these lines are very faint in the solar spectrum, and are unrecorded by Angström, while they are wide and dark in the spot-spectrum.

12. In the months of May and June of this year (1881), there was a great change in the spectra of the spots, the old lines dying out and new lines appearing.

13. When series of observations, consisting of ten consecutive observations of the spectra of spots, taken from the commencement of the first series in November, 1879, and from the end of it on 7th September, 1880, were compared with those made towards the end of the second series on 18th July, 1881, it was found that the lines widened in each set were markedly distinct from those in the other sets. To show this, I lay the maps containing the three sets of observations before the Committee.

14. At the commencement of October, 1881, there was a change in the spectra of the spots similar to that which took place in May and June, but much more abrupt, for only one of the old lines remained. This is exactly analogous to the variations Tacchini saw in the spectra of the prominences in the region F to *b*, in December, 1872.

15. In the first series of observations the total number of most widened lines in the region F to *b* was fifty-seven, forty of which were due to iron, whilst in the second series the total number of lines seen was 104, and the iron lines faded away gradually, the last disappearing on 26th July, 1881.

16. So far as the observations have gone there has been no difference caused by the nearness of the spot to the limb.

17. At the present time more than 75 per cent of the most widened lines are not represented in the spectra of terrestrial elements.

18. A line of titanium at wave-length 5865·0 and a line of barium at wave-length 5852·5 are amongst the recent most widened lines. Both these are long lines in the

* Summary of a Paper read before the Royal Society, December 15, 1881.

† A Paper read before the Royal Society, December 15, 1881. Communicated to the Royal Society at the request of the Solar Physics Committee.

spectra of these metals. The line at wave-length 5852·5 has been seen by Young in flames, with a frequency of eight.

ON A NEW ELECTRICAL STORAGE BATTERY.*

By HENRY SUTTON, Ballarat, Victoria.

THE great utility of some thoroughly practical method of conserving electric force has caused a great deal of attention to be applied to the subject; no system of electric supply can be considered as perfect until some means is used to so store the force generated that it may be drawn off equally and regularly, and this whether the generator be on or off. If we take, as an example of electric supply, the present systems of electric lighting, it is at once seen, should an accident or stoppage take place in the machinery generating the current, the whole of the apparatus, such as lamps or motor-machines are influenced; should there be a reservoir of electricity between the generator and the apparatus of whatever sort for utilising the force this inconvenience would not occur.

All the present systems of storing electricity depend on certain chemical changes produced by electrolysis.

I have gone through a long series of experiments on storing electricity and made many forms of cells, one being a porous pot containing dilute hydric sulphate, and a sheet of lead, in an outer vessel, containing a sheet of lead in solution of acetate of lead, the plate in the porous pot being made the positive electrode: this cell had the power of storing electricity, by peroxidising the positive electrode, and depositing from the acetate of lead solution metallic lead on the negative electrode, the hydrogen having combined to form acetic acid. On discharging the peroxide is reduced, and the oxide formed during discharge on the other plate dissolving in the acetic acid forming the original solution of acetate of lead; by this means I eliminated the injurious effects of the hydrogen on charging.

During my experiments I found that red oxide of lead is a very bad conductor of electricity, and the peroxide a good conductor. I also discovered that by amalgamating lead plates with mercury a marked increase was immediately manifest in polarisation effects, the plates becoming more uniformly and rapidly peroxidised when used as positive electrodes, and local action entirely disappearing. These mercury amalgamated plates at once gave me an advance of other cells. I used them in many ways, constructing cells in which the positive plate was amalgamated, and the negative coated with red oxide, or with peroxide, produced by treating red oxide with dilute hydric nitrate till the brown precipitate of peroxide fell, the precipitate being washed and painted on the electrode. I also amalgamated the negative electrode simply. I found that in every way positive electrodes amalgamated produced the best results. I also made cells in which either peroxide or red oxide was formed into a porous conglomerite, using the conglomerites as electrodes, immersed in dilute hydric sulphate. I constructed cells with parallel plates, red oxide or peroxide being filled in between the plates: in this experiment red oxide is useless and peroxide efficient. In all these experiments I succeeded in storing electricity to different extents.

Having thoroughly satisfied myself that positive electrodes amalgamated with mercury were the best, I investigated the behaviour of various forms of negative electrode, having in view the conservation of the hydrogen; this I thought to do by occluding the hydrogen in suitable electrodes, as spongy platinum or metallic palladium; but as both these methods would be useless owing to expense I did not even experiment on them.

I further thought that by having negative electrodes, whose oxides should be soluble in the solution, and which could be re-deposited from the solution, or by having metallic solutions from which metal could be deposited, the resulting solution being such that should, on the oxidation of the deposited metal, combine with the oxide and again form the original solution.

I thought that success in this manner would result in a powerful and constant source of stored energy, the cell would not polarise itself during discharge, as is the case in both Planté and Faure cells; in these cells the pesoxide formed by the discharge produces a contrary electromotive force.

Experimenting from this train of thought, the results I have obtained are such as to have an important practical bearing on the future of electric work.

The experiments comprised amalgamated lead as a positive electrode with negative electrodes composed of either zinc, iron, or copper, in each case the solution between the electrodes being a salt of the metal composing the negative electrode. With zinc, sulphate of zinc was the solution; with iron, sulphate of iron; and with copper, sulphate of copper being the solution. In all these cases the results were not only far more powerful than any form of cell I had previously devised, but also very constant, the polarisation lasting many times longer than any other form of cell. The cell with zinc negative electrode I discarded, owing to the necessity there would be to keep the zinc plate amalgamated to prevent local action, the iron negative electrode being set aside owing to the iron oxidising when the cell was not in use. The cell having a negative electrode of copper, a positive electrode of lead amalgamated with mercury and a solution of cupric sulphate, I have adopted as a thoroughly economical, lasting, and practical form of storage reservoir. The chemical changes in this cell are exceedingly interesting and beautiful, the cell being composed of a sheet of lead cleaned with dilute sulphuric acid and amalgamated thoroughly with mercury, and a sheet of thin copper a little shorter; the two sheets are perforated with a number of holes and then rolled in a spiral, separated by rubber bands cut every five inches, the holes in plates and cuts in rubber bands being to allow free circulation of the solution (the short plate being uppermost before rolling). This combination is immersed in a solution of cupric sulphate, and the amalgamated lead plate made the positive electrode of a suitable source of electricity. The chemical action being the oxygen of the decomposed solution combines with the lead, forming a perfectly even coating of the insoluble peroxide, the hydrogen replacing the copper of the solution, the copper being deposited in the metallic state on the negative electrode. As the decomposition of the cupric sulphate proceeds it gradually loses its azure blue colour, becoming more acid, and finally when the whole of the copper is deposited, we have the solution colourless and transformed into hydric sulphate and water, the positive electrode peroxidised and copper deposited on negative electrode. During discharge the peroxide is reduced and the copper element oxidised, the oxide combining with the acid and forming cupric sulphate, the solution returning to its original colour. This change of colour forms a beautiful means of telling when the cell is charged; it is a veritable charging gauge. The power of this cell is very great and very constant; it can be made to last for hours, the time being dependent on the quantity of cupric sulphate decomposed.

I have, by the decomposition and recomposition of one pint of cupric sulphate, obtained over two hours' effective work by heating to a red-heat one inch of No. 28 iron wire, the cell measuring internally 4 inches deep and 4 inches diameter.

I constructed cells with free crystals of cupric sulphate suspended in the solution, and found that the presence of free crystals prevented the oxidation of the amalgamated lead electrode, it being essential that the solution becomes slightly acid before the peroxide will form. The cell during charging gives out a peculiar rattling noise, which I consider due to the deposition of copper on negative electrode altering the form of the spiral.

* A Paper read before the Royal Society, December 15, 1881.

A practical form of cell for storing purposes ought to be made by fixing a series of amalgamated lead plates in a box in grooves, as in Cruikshank's trough battery, filling between the plates with solution of cupric sulphate, and passing a current through of sufficient tension to overcome the contrary electromotive force of the series, the positive sides of plates being peroxidised and copper deposited on the negative sides. I have two boxes on this plan, each containing twenty-five plates, the total being equivalent to fifty cells. By this means batteries of great tension can be charged from thirty Bunsens. A number of twenty-five plate boxes can be coupled in quantity for charging and tension during discharge. Twenty such boxes, 1 foot square, internal measurement, will give in series a battery of 500 pairs 1 foot square plates.

It will be seen from the foregoing that this method of conserving energy has a wide field before it, and as it will benefit fellow-workers in science, placing in their hands a means of experimenting with powerful electric currents, I give it without reservation, freely and untrammelled by patent rights for their use.

ON THE

ESTIMATION OF NEUTRAL FAT AND PALMITIC AND OLEIC ACIDS IN PALM OILS AND AUTOCLAVED MATERIAL.

By FREDERICK SEAR, A.I.C.

Dissolve about 5 grms. of the palm oil or autoclaved material with 100 to 150 c.c. carbon disulphide in the cold, in a flask provided with a well-fitting cork. The whole is then allowed to stand for three or four hours with occasional agitation. At the expiration of this time, the contents of the flask are thrown upon a filter (the filtrate being collected in a tared flask), thoroughly washed with carbon disulphide, and the filtrate distilled as low as possible on a water-bath, dried, and weighed. The residue, which consists of neutral fat and zinc oleate, is saponified with alcoholic potash, the soap decomposed with an acid, the aqueous portion separated from the fatty acids, and the zinc precipitated from a hot solution by means of potassium carbonate. The zinc carbonate is then collected, and estimated as such, or as zinc oxide, and the quantity of zinc oleate to which it corresponds calculated. Subtracting this from the weight of the mixture of neutral fat and zinc oleate, the weight of the former is obtained. The amount of oleic acid is calculated from the zinc oleate. By adding together the weights of the neutral fat and oleic acid and subtracting from the weight of the oil taken, the quantity of palmitic acid is ascertained.

The following example will serve to illustrate the above:—

5·439 grms. of a palm oil gave 4·300 grms. neutral fat and zinc oleate.

Zinc carbonate obtained 0·2445 grm., equivalent to 1·2265 grms. zinc oleate and 1·1030 grms. oleic acid.

4·300 − 1·2265 = 3·0735 grms. neutral fat. Therefore 5·439 substance gave:—

		Percentage.
Neutral fat	3·0735	= 56·509
Palmitic acid	1·2625	= 23·208
Oleic acid	1·1030	= 20·283
	5·4390	100·000

Lactic Acid, and the Alcoholic Fermentation of Milk.—Dr. G. Musso.—Lactic acid does not exist in freshly-drawn milk. Whenever it is formed there appears an alcoholic ferment, and ponderable quantities of alcohol are formed.—*Biedermann's Centralblatt.*

CHEMICAL METHODS FOR ANALYSING RAIL-STEEL.*

By MAGNUS TROILIUS, Chemist to C. P. Sandberg, London.

(Continued from page 294.)

Phosphorus Determination.—The greater number of steel-works which I have visited use the Eggertz's molybdic method for determination of phosphorus in steel. Except in Sweden, however, it is only at one large works in Germany that I have seen this method carried out in the way originally described by Professor Eggertz, and at those works superior appliances, &c., enable the manipulators to obtain pretty quick, and certainly very accurate, results, even when using weighed filters, and working upon the small prescribed quantity of one gramme. At other German works it was the practice to re-dissolve the phospho-molybdate obtained, and to finish the analysis by the magnesia method. But at all the English and Welsh works with which I am acquainted the phosphorus is estimated by weighing the phospho-molybdate itself. Several grammes of the steel are always used, and the precipitate is generally brushed off from the filter. Only at one Welsh works have I seen it gently burnt, so as merely to incinerate the filter.

The former of the two last-named modes of manipulation is the one I use. Like so many other useful modifications in the chemistry of iron and steel, this plan was originally introduced at Dowlais by Mr. Snelus. In the following pages I will describe the process, and, at the same time, refer briefly to the Welsh "burning" method and to the magnesia method, &c.

The Burning Method.—The solution of the steel for the determination of phosphorus is an easy operation. Not less than 5 grms. of steel are dissolved in a mixture of equal volumes of strong nitric and hydrochloric acids. (I use for this purpose nitric acid 1·42, and hydrochloric acid 1·195 sp. gr.) No loss through escape of phosphorus in combination with hydrogen is hereby incurred. The solution is evaporated to dryness, and heated until all dark fumes have ceased to escape. A beaker or a porcelain dish may be used, according to circumstances, and evaporations, &c., are performed on the hot plate. By the evaporation to dryness the complete solution of the steel is secured, all organic matter is destroyed, and the silica can be separated, which is advisable if it is present in any noticeable quantity.

The dry mass is then dissolved in strong hydrochloric acid, the excess of acid removed by evaporation, hot water added and the silica filtered off. (If little or no silica is present it is, of course, unnecessary to filter it off, and the precipitation of phosphorus may then at once be proceeded with.) The filtrate is evaporated down to a small bulk, so that it is only just fluid; it is allowed to cool, and then about 4 cc. of the strong nitric acid are added. A little rinsing water is introduced so as to make the bulk about 20 cc. The beaker is strongly shaken in the right hand, while from a pipette, which is held in the left hand, 20 cc. of the solution of molybdate of ammonia are allowed to run into the beaker in a thin stream.

The solution of molybdate is prepared by dissolving 100 grms. of molybdate of ammonia in 1000 cc. of water and 100 c.c. of ammonia, 0·88 sp. gr. It is of no advantage to use less strong solutions of molybdate than this, as one has then to employ a larger quantity of the same, and thus obtain a greater bulk, the work being thereby retarded.

After pouring in the solution of the molybdate a few drops of ammonia (0·88) are added, and the beaker is shaken until the precipitate of iron has disappeared. The phospho-molybdate is then completely down, and you have only to leave the beaker on the less hot part of the plate at least for one hour, during that time allowing it to settle, and

* Read before the American Institute of Mining Engineers October, 1881. From the *Journal of the Franklin Institute.*

shaking it up again repeatedly. After the last shaking the precipitate must separate distinctly, and leave a perfectly clear, supernatant solution. There is no danger of getting molybdic acid down, even if you were to boil for a moment or to use a large excess of molybdate, provided that there is a sufficiently large quantity of nitric acid present; but, if there is arsenic in the steel, this will come down along with the phosphorus, and cause too high results. The using of the ammoniacal solution of molybdate and ammonia causes a considerable elevation of temperature; hence, as will be shown below, the precipitation of arsenic.

After settling, pour the liquid on a good Swedish 4 inch filter; wash the filter with cold water containing 1 per cent of nitric acid until it is quite white; wash the precipitate in the beaker once by decanting with ordinary water, moderately hot, and finally wash the precipitate down on the filter, and collect it at the centre with as few washings as possible with ordinary water, moderately hot. The filter should be quite white before the precipitate is washed on to it.

If the washing is conducted in this way no loss will be incurred in dissolving, neither will the fluid run thhrough turbid. The solubility of the phospho-molybdate precipitate, at 16° C., is given by Professor Eggertz as follows:—

In pure water, ...	1 part in 10,000
In water, with 1 per cent of nitric acid	1 ,, ,, 6,600
In hydrochloric acid, 1·12	1 ,, ,, 550
In nitric acid, 1·2	1 ,, ,, 190

If to the solvent be added a solution of molybdate of ammonia, equal to about half of its volume, the solvent action seems to be considerably lessened.

After washing, unfold the filter containing the precipitate upon another filter and put it upon the edge of the plate to dry. The unfolded filter should be covered with a large watch-glass, so as to prevent dust from getting into it. As to the temperature for drying, this is by no means so essential a point as is often supposed, and the precipitate may be dried for hours at a temperature between 100° and 140° C. without changing its percentage of phosphorus in any noteworthy degree, as stated by Professor Eggertz, whose results in this respect are compiled in the following table:—

Temperature	Loss per cent of weight of precipitate.
95°—100° C.	0·40
100°—120° C.	0·20
120°—140° C.	0·05
95°—140° C.	0·65

The total loss in weight is thus only 0·65 per cent when drying at 140° C., and this has no practical influence, considering the small amount of phosphorus in the precipitate and the large quantity of steel operated upon. The precipitate also retains its yellow colour at the temperature of melting lead (355° C.), but gets black at the temperature of melting zinc (400° C.)

When dry, the precipitate is shaken down into a weighed platinum, or porcelain dish, the brush not being applied until nothing more can be loosened from the filter by mere shaking. It is a convenient practice to hold the filter in the left hand, and to knock gently on this hand with the other.

Having thus given the outlines of my mode of using the molybdic method, I would add the following precautions, which are necessary for attaining accurate results:—

1st. Removing excess of hydrochloric acid from the solution by evaporation.

2nd. Adding the solution of molybdate in a very thin stream, shaking well.

3rd. Great care in the washing and brushing off.

As for the weighing, it is advisable to dry in the vessel repeatedly, and weigh two or three times before deciding the weight finally.

In *Eggertz's original method* there is used for the determination of phosphorus in steel only 1 grm. The solution of molybdate is prepared from 100 grms. pure molybdic acid to 422 c.c. ammonia (0·95 sp. gr.), and 1250 c.c. nitric acid (1·2 sp. gr.). By using such a small quantity of steel one advantage is gained, viz., that no evaporation after separation of the silica is required, the bulk being very small if the washing has been carefully performed. But, of course, brushing cannot be applied when such a small quantity of steel is taken. Weighed filters have to be used.

As to the precipitation in this case, you may manage to have the iron solution of 15 to 20 c.c. volume, and add to the same at least half its volume of the above-mentioned solution of molybdate. The solution is well stirred and left at a temperature of 40° C. for 1 to 3 hours, after which the precipitate is collected on the weighed filter, dried and weighed.

In Sweden it is of great importance to keep the temperature not above 40° C., as some of the very purest Swedish irons and steels contain arsenic, which will come down as a yellow precipitate similar to the phospho-molybdate. At 70° C. this arsenio-molybdate (containing 4·11 per cent of arsenic) comes down pretty quickly, and, on boiling, it precipitates at once. It is easy to understand how important it must be to avoid estimating the arsenic as phosphorus in, for instance, a Dannemora "Walloon" iron, where the phosphorus may be only 0·01 per cent or less. If the right temperature be neglected the phosphorus would, perhaps, appear to be 0·02 per cent; but this would still be serious in such pure material. In fact, it is to be feared that many mistakes on the part of consumers o Swedish steels are committed through overlooking the presence of arsenic.

It falls beyond the limits of this paper to describe Prof. Eggertz's method for separating and determining the arsenic in steel, and I have only to mention that I have not been troubled with arsenic in any of the rail-steels with which I have had to do.

The Burning Method.—As to the method of burning the precipitate above referred to, I may say that I saw it practised two years ago at a large works in South Wales, but not until lately have I had time to try it myself. At the works in question it was the practice to put the wet filter containing the precipitate in a platinum crucible, and to place this in the fore part of a hot muffle-furnace, so as to incinerate the filter. A certain correction, as I was told, was made for the expelled ammonia before taking down the result. However, I have found hitherto that by adding the filter to the precipitate after determination by the brushing method, in the usual way, and putting it all into a weighed porcelain crucible, then carefully charring the filter and burning it over a gentle flame from a Bunsen burner, no very different results are obtained; indeed, in most cases I have found the weight, after burning, only so much *higher* than after brushing, as would correspond with the weight of the filter-ash, and in no case have I found it less than after brushing. It appears that 140° C. is the highest temperature that can be used when only drying of the precipitate is intended, for at higher temperatures the filter paper begins to change. But, as far as the above-named experiments show, it is quite feasible to incinerate the filter without practically altering the composition of the precipitate. A continued series of such experiments will give a list the average of which will show the accuracy obtainable by the burning method.

(To be continued.)

Manurial Experiments on Fruit Trees.—Dr. P. Sorauer.—If liquid manures are too much diluted the trees are injured by being compelled in seeking nourishment to take up more water than they need. On the other hand, too concentrated solutions occasion a decay of the roots. —*Biedermann's Centralblatt.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 15, 1881.

Prof. H. E. ROSCOE, President, in the Chair.

THE following certificates were read:—H. L. Buckeridge, J. F. Heyes, T. Pitt, G. McRobert. During the evening a ballot was held, Messrs. Makins and Warington being appointed Scrutators. The following gentlemen were declared by the President to be duly elected Fellows of the Society:—C. Armitage, D. E. Anatole, J. Bingley, C. H. Bothamley, J. D. Custance, G. W. H. Clements, T. Farmer, A. B. Griffiths, R. P. Gardner, W. B. Harrington, H. E. Head, J. Innes, W. Jackson, R. V. Jackson, P. S. Looker, R. F. Mathews, K. D. Naegamvala, J. B. Orr, W. F. Reid, W. Rupp, H. Ross, F. Sear, C. H. Sieber, J. W. G. Stevens, C. H. Slaytor, D. R. Steuart, B. E. Smith, C. A. Still, R. Tervet, J. S. Topham, Rev. E. W. Volckxson, B. Wilkinson, J. Whitlock.

The PRESIDENT then called on Mr. V. H. VELEY to read a paper entitled "*On some Higher Oxides of Manganese and their Hydrates.*" The author has carefully prepared pure oxides of manganese containing less than 1 per 1000 of potassium and 1 per 6800 of calcium. He has heated the higher oxides in currents of nitrogen and in pure hydrogen, estimating the water evolved and the loss of weight of the oxide. The temperatures used varied between 80° to 200°; a few experiments were made at higher temperatures. At certain points in the thermometric scale the manganese compound remained unaltered on continued heating at that temperature. On this ground the author concludes that a definite oxide or hydrate was formed. On raising the temperature, a further loss of water or oxygen takes place, until another point in the thermometric scale is reached, at which the manganese compound again remains unaltered on continued heating at that temperature; the author concludes that another definite oxide or hydrate is formed, and so on. By such experiments the author has established the existence of the following substances: $Mn_{24}O_{32},3H_2O$; $Mn_{24}O_{44}$ with 8, 6, 4, and 2 molecules of water; $Mn_{24}O_{458}H_2O$; $Mn_{24}O_{46}$ with 3 and 2 molecules of water; $Mn_{24}O_{472}H_2O$. The author has determined the specific gravity of some of these oxides. He concludes with some theoretical discussion as to the probability of the metallic oxides having formulæ much more complicated than those usually assigned to them.

Mr. HOWARD then read a paper "*On a New Alkaloid from Cinchona Bark,*" by D. HOWARD and J. HODGKIN. The authors have discovered in the bark of China *Cuprea*, described by Dr. Flückiger, an alkaloid which appears to be peculiar to the species, which is quite distinct from that described by Arnaad under the name of cinchonamine (*Akad. Sci.*, 93, 593). This bark, first imported in 1871, differs much in its extreme hardness and tenacity from all other cinchona barks. During the last few months large quantities have been sent over from Buccarramanga, in the province of Santander, where it is said to form vast forests. The bark varies greatly in value, some specimens containing no quinine, others upwards of 2 per cent; some quinidin and cinchonin are also found in the bark, but no cinchonidin. The new alkaloid in its general properties and composition of its platinum salt closely resembles quinine. It differs only in the solubility of its salts and the readiness with which the alkaloid crystallises from ether. The authors suggest the name homoquinine. 100 c.c. of ether dissolve 0·57 of the alkaloid at 12°. It is much more soluble when other alkaloids are present, and is very apt to show supersaturation. The sulphate crystallises in shorter needles than the quinine salt, and contains 6 atoms of water. Water at 100° dissolves 1 per cent; at 12°, 0·25 per cent. The disulphate is extremely soluble and fluoresces. The oxalate, tartrate, hydrochlorate, nitrate, and hydriodate were also prepared. The rotation of the alkaloid and its salts is almost identical with that of quinine. Further investigations on larger quantities of the alkaloid are promised.

Mr. COWNLEY said that in conjunction with Dr. Paul, he had discovered some months back an alkaloid in *Cuprœa* bark which differed from the other well-known cinchona alkaloids. They had experienced some difficulty in obtaining it pure, but during the last few weeks had succeeded. The communication was already in type, and would appear in the *Pharmaceutical Journal* of this week. He was therefore very much surprised to hear Messrs. Howard and Hodgkin's paper, which apparently described the same alkaloid.

In answer to several questions, Mr. HOWARD said that in the present state of legislation, he had not thought it desirable to test the physiological action of this alkaloid on any other vertebrate than himself. The amount of alkaloid varied, but was usually about 10 per cent of the quinine present. He was quite delighted to hear that the presence of this alkaloid had been simultaneously confirmed by the experiments of Mr. Cownley.

The PRESIDENT then left the Chair to communicate a paper entitled "*Contributions to the Chemistry of the Rare-Earth Metals,*" by B. BRAUNER.

The Chair was taken by Dr. Voelcker.

The PRESIDENT said that this communication was interesting as being the first fruits of a system of Science Fellowships, founded at Owen's College. The Fellowships were given not by competitive examination, but to those candidates who had shown most ability and power in original research. The principal object of Dr. Brauner's research was to determine the position of the cerite metals in the periodic system by a careful study of their compounds. Mendelejeff places cerium (Ce=140) in the fourth group (vertical), but is doubtful as to position of lanthanum and didymium. Lothar Meyer places cerium (Ce=137) in the third group, La=139 in the fourth group, and Di=147 in the sixth; afterwards he places all three elements—La 139, Di 140, Ce 141—in the third group. The author some years ago proposed that these metals should be placed in the eighth series (horizontal) in the third, fourth, and fifth, thus—

	Group III.	IV.	V.
Series 8	La 139	Ce 141·6	Di 147

If cerium belongs to the fourth group it should have a tetrafluoride, CeF_4, as the existence of such a body was not by any means established. The author first prepared some pure hydrated dioxide, $Ce_2O_4+3H_2O$. By treating this with aqueous hydrofluoric acid, a brownish powder was obtained, having the formula CeF_4+H_2O. When heated this substance evolves hydrofluoric acid and a gas, which liberates iodine from potassium iodide, possibly according to the equation $CeF_4.H_2O=CeF_3+H_2O+F(?)$. A double salt, $3KF.2CeF_4+2H_2O$, was also obtained as a yellowish white crystalline powder. The author then proceeded to study peroxide of didymium. Didymium sulphate was first purified by a long series of crystallisations, and finally precipitated from the hot aqueous solution by oxalic acid. On ignition, &c., a pure oxide was finally obtained, the hydrochloric solution of which gave the spark spectrum of pure didymium. By analysis of the pure sulphate the atomic weight of didymium was determined as 146·58 (O=16, S=32·074). After many unsuccessful experiments the author succeeded in preparing hydrated and anhydrous peroxide of didymium. The hydrated compound is obtained as an amorphous green precipitate by adding dilute caustic potash to a mixture of didymium nitrate and hydrogen dioxide until a slightly alkaline reaction is produced. After drying *in vacuo* a light red powder is obtained, $Di_2O_5+3H_2O$. By heating basic nitrate of didymium in a current of oxygen in a porcelain boat to dull redness, the anhydrous Di_2O_5 was

prepared as a brown mass. It is soluble in dilute acids without evolution of gas, but with strong acids oxygen with some ozone is evolved. It is only slightly soluble in cold concentrated solution of ammonium nitrate. The author then prepared some perfectly pure lanthanum oxide, and determined the atomic weight of that metal to be 139·88 (O = 16). Nilson and Pettersson have recently published a series of objections to the periodic system, one of which was the difficulty of placing the rare-earth metals. The results of the present paper prove that with Ce, Di, and La, this difficulty does not exist, the author placing these elements in the eighth series, and in the fourth, fifth, and third groups, respectively, thus—

Series 8.. Cs 133 Ba 137 La 139 Ce 141·6 Di 146·6

The author points out the relations of these three metals, and expresses his conviction that further research, especially as to the higher oxides, will probably find a satisfactory place for the other rare-earth metals in the periodic system.

Dr. VOELCKER congratulated Prof. Roscoe on the excellent paper which had just been read. Few who had not worked with these rare metals could form any idea of the patience and skill required merely to prepare the substances in a state of purity. The work seemed to have been carried out with great skill and accuracy, and all must agree that it was most desirable that we should know where to place these rare metals in the periodic system.

In answer to Dr. WRIGHT, Prof. ROSCOE said that none of the compounds had been obtained in the state of vapour, and therefore no vapour-density determinations had been made.

Mr. NEWLANDS said that he would like to mention how much pleasure it gave him to see the periodic system prosecuted to such a successful issue by Mendelejeff. When, some years ago, he (Mr. Newlands) first broached the idea that the elements could be arranged in periods of eight, his notions were very unfavourably received; now, although there were undoubtedly gaps in several places, yet further researches seemed to fill up the missing links, and generally confirm the truth of the arrangement.

The Society then adjourned over the Christmas vacation to January 19, 1882.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Monday, November 7, 1881.

Mr. J. MACTEAR, F.C.S., F.I.C., President, in the Chair.

AFTER the transaction of some formal business, Mr. Mactear delivered the opening address as President of the Section.

On the conclusion of Mr. Mactear's address, Dr. WALLACE, President of the Philosophical Society, on behalf of the Trustees of the Graham Medal and Lecture Fund, presented Mr. Mactear with the Graham Medal for 1881-82. In making the presentation, Dr. Wallace gave an account of the origin and objects of the Graham Fund. He said that it had been instituted for the purpose of commemorating the services rendered by Graham to chemical science. Part of the money subscribed to the Fund had been devoted to the foundation of a triennial gold medal for the encouragement of original research, and the remainder to the foundation of a triennial lecture. The competition for the medal had been thrown open to all comers, and had been advertised in the CHEMICAL NEWS and in *Nature*. Of eight papers sent in for the first competition, four were from gentlemen unconnected with Glasgow. The Committee entrusted with the management of the Fund had placed the papers in the hands of Prof. Williamson, of London, who, after careful and repeated examination of them, had reported in favour of one submitted by Mr. Mactear, entitled "Some Researches on the Reactions involved in the Leblanc Process of Alkali Manufacture." In accordance with this report the Committee had awarded the Medal to Mr. Mactear. Having referred to the high estimation in which Mr. Mactear is held by all scientific chemists, as well as by those more immediately connected with alkali manufacture. Dr. Wallace concluded by handing Mr. Mactear the Medal, which bore the inscription—Graham Medal, 1881-82, Awarded to James Mactear, F.C.S., F.I.C.

NOTICES OF BOOKS.

Letts's Diary for 1882; *No.* 8. *Letts's Housekeeper's Account Book and Diary for* 1882. *Letts's Rough Diary and Scribbling Journal for* 1882, *No.* 36. *Letts's Medical Diary for the Year* 1882. *Letts's Pocket Diary and Almanac for* 1882; *Nos.* 13, 17, 22. *Letts's Metallic Diary for* 1882; *No.* 60. London: Letts, Son, and Co., Limited.

WE have here an assortment of diaries differing widely in price, contents, arrangement, and style, so as to suit varied tastes and requirements. No. 8 is a goodly volume for the office, containing an almanac of a somewhat antiquated character; Jewish and Mahommedan kalendars; telegram rates, both English and foreign; revenue and postal information; directions for making wills; weights and measures; the Corporation of London; the Administration; list of Colonial Governors and of Colonial Agents; the Royal Family; London bankers; a Colonial and Foreign banking, postal, and telegraph directory; a country banking, postal, population, and market table; a parliamentary guide; a list of the Officers of State: British Ambassadors abroad; foreign representatives in England; law and public offices; insurance companies in London; tide tables; London cab fares; registration laws; and a great variety of statistical information. A curious feature is the so-called "Concise Directory." We fail to understand why certain trades and professions have been inserted and others omitted, or why certain tradesmen have been selected in preference to others. We think, *e.g.*, there are in London opticians quite as eminent as Marratt and Ellis, and publishers not less respectable than Burns and Oates. Letts's Housekeeper's Account Book contains the same almanac and directory; a monthly list of articles of food in season; alimentary tables showing the amount of nutrition in 1000 parts and the time required for digestion, and accompanied by the remark that "to generate vital heat is the real object of alimentation." A very useful feature is a register of books, &c., lent to friends. For want of keeping such a record many persons find their libraries waning imperceptibly away.

The Rough Diary is a plain little volume containing the almanac and some statistical information. The diary portion is ruled for money, and contains seven days to the page.

The Medical Diary is bound for the pocket. Here the almanac is freed from the antiquated matter contained in the other diaries in order to allow of entering the meetings of Societies. It is somewhat curious that in none of these diaries do we find a list of the London learned societies with the addresses of their secretaries, &c. Among the peculiar features of the Medical Diary may be mentioned a scale of professional fees. It strikes us that the charges allowed by the Poor Law Board and the Courts of Law are very low. Thus the fee for a *post mortem* examination—which it appears may include analysis of the contents of the stomach—is merely one guinea. We should think five guineas quite little enough for the toxicological examination alone, if it is to be accurately and conscientiously performed. There are tables of poisons and

antidotes, and a classified list of medicines. The diary portion seems exceedingly convenient in its arrangement.

The diary No. 13 is a small volume of a side-pocket size, ruled for memorandums, and giving the week on two pages.

No. 17 is in the form of a neat pocket-book, and gives a week to the page. No. 22 is a more elegant pocket-book, bound in Russia leather, and fitted with pockets lined with green silk. It shows four days to the page. No. 27, lastly, is of a waistcoat pocket size.

All these diaries are neatly and serviceably got up, and well deserve the public patronage.

Experiments showing the Pressure of Gas in the Solid Coal. By Lindsay Wood. Newcastle-upon-Tyne: A. Reid.

This work is a reprint from the *Proceedings of the North of England Institute of Mining and Mechanical Engineers.* The author undertook to ascertain if gas existed at any pressure in the solid coal; what quantity of gas was given off from a given area of a face of working coal; and at what rate this exudation diminishes per hour of exposure. The results are somewhat startling. In the Elemore Colliery, 750 feet below the suriace, a hole was bored into the solid coal to the depth of 7 feet, and fitted with a pipe connected to a Bourdon's pressure-gauge. In the first five minutes the pressure was 13 lbs. per square inch. In eleven and a half hours it had risen to 28 lbs., and at the end of twenty-six days it was found to have fallen to 8½ lbs. At Hetton Colliery an experiment was made at the depth of 1228 feet below the surface with a borehole 9 feet long. The pressure here was at first 8½ lbs.; the next day it had risen to 40 lbs. At 8 p.m. the same day it had fallen to 35 lbs.; but it rose again, and two days eight and a half hours from the beginning of the experiment it reached a maximum of 45 lbs. After this it fell to 40 lbs., and remained at that point till the experiment was discontinued. In the Eppleton Mine, at the depth of 1261 feet, the maximum pressure reached the astonishing figure of 104½ lbs. In another experiment we find a maximum of 204 lbs., the pressure remaining at or above 200 lbs. for nearly two days! At Eppleton, No. VI., we find a pressure of 221 lbs. recorded; at Boldon, 386 lbs.; and in a further experiment 461 lbs. The experiments appear to have been made in five distinct groups of mines. The lowest pressure was found, as might be expected, in the pits which have been longest opened up. The pressure does not seem to have any fixed connection with the depth below the surface, but bears some relation to the distance from the face of the coal in the workings in which it is ascertained. Those places where the pressure of gas is greatest do not seem to give off the largest volumes of gas. Neither is there any connection between the state of the barometer and thermometer on the one hand, and the quantities of gas evolved on the other. The writer having ascertained these important, and we may say suprising, facts, does not profess to enter upon a full discussion of the results, but considers that further experimentation will be needful.

Practical Chemistry, adapted to the Revised Syllabus of the Science and Art Department, with an Introduction to Chemical Analysis. By J. Howard, F.C.S. New and Enlarged Edition. London and Glasgow: W. Collins, Sons, and Co., Glasgow.

This work is distinctly and avowedly examinational. We are told in the preface that the reports of the eminent men who act as examiners for the "Department" had shown that many students who come up for examination were mere readers, and they rightly decried such a system of cram, which could only produce nausea instead of that deep interest in the phenomena surrounding us which would be produced if science were studied practically. We fear that so long as examinations are held up as the end and aim of study no deep interest in natural phenomena will ever be felt. If we could be permitted to study simply in order to know and to qualify ourselves for adding to the present stock of human knowledge a deep interest would not be wanting, but this the department and the eminent men aforesaid will not permit.

We are glad to find that the notation and formulæ used by Professors Roscoe, Williamson, and Thorpe now find a place in this treatise, in addition to the Franklandian system. Mr. Howard's work seems well adapted for its purpose, though how all the numerous elementary works on chemistry find sufficient scope is an unsolved mystery.

Chemical Notes and Equations for the Use of Students. By R. Milne Murray, M.A., M.B., M.R.C.P.E. Second Edition. Edinburgh: Maclachlan and Stewart. London: Ballière, Tindall, and Cox.

This pamphlet—for it does not extend to 110 pages—professes to supply the student with a condensed view of the principles of chemistry, and "a tolerably complete synopsis of the more important relations and reactions of the chief elements and their compounds." It is considered that the work may serve for refreshing the memory of the intending examinee. The selection of the elements is peculiar, forty-two simple bodies only being mentioned, including cæsium and rubidium, which are named merely to be dismissed as not requiring notice. Vanadium, rhodium, iridium, and palladium are not described. Whilst the information here given is generally accurate as far as the very confined space will allow, we think exception may fairly be taken to the process given for obtaining potassium bichromate from chrome-iron ore, viz., obtaining first the mono-chromate and then treating with nitric acid.

CORRESPONDENCE.

SOAP TEST FOR HARDNESS OF WATER.

To the Editor of the Chemical News.

Sir,—During a considerable experience in water analyses one or two points have occurred to me which I think may probably be of interest to my fellow-workers.

Those who have had much experience of the method of determining the hardness of potable waters are acquainted with the difficulty and annoyance experienced in consequence of the decomposition of the soap test solution, which retains its original strength but for a short time after being made. This troublesome character I have succeeded in averting by the following method.

I make the soap test of the best Castile soap, as recommended by Prof. Wanklyn, using methylated spirit diluted with 2 vols. water. When all the soap is dissolved I add sufficient strong ammonia solution to make the test distinctly alkaline, and then standardise the soap solution in the usual way with calcic chloride.

The solution thus prepared will, when kept in the dark, keep for a considerable time without undergoing decomposition. I have had some in use for over two years, and my experience in this respect has been corroborated by several friends.

The alteration of the ordinary soap solution is due, I presume, to the decomposition of the fatty acids contained in the soap, which, when an excess of ammonia is present, remain fixed.

When taking the hardness of a water it is absolutely essential, in order to obtain correct results, to add the soap test until a full lather is obtained, and above all things to be careful to dilute with distilled water after soap test equal to 16° hardness has been added. Neglect of these precautions will often lead to very erroneous re-

sults. A case lately came under my notice in which the chemist added only just sufficient soap test to make a slight lather, and immediately took that point as the true degree of hardness, a practice which, in the case in question, entirely misled him.

In making Nessler's test I find it much better not to heat the solution of potassic iodide and mercuric chloride, but to effect solution in the cold, and to add the caustic alkali when cold also, when no precipitation will take place, and the test will be quick at once, no further addition of mercuric chloride being necessary.—I am, &c.,

W. J. Dibdin, F.I.C., F.C.S.

37, St. Stephen's Avenue, Shepherd's Bush, W.
December 14, 1881.

WASH-BOTTLE.

To the Editor of the Chemical News.

Sir,—Will you kindly allow me to state that the wash-bottle described by Mr. A. E. Johnson in the Chemical News, vol. xliv., p. 213, is, as far as I can make out, almost identical with one described by me in the Chemical News, vol. xxxix., p. 19. The only difference being in the position of the india-rubber tube, which may be made to act as a valve. In Mr. Johnson's it is at the *side*, while in mine it stretches across the *top* of the stopper.

I may be permitted to add that nearly four years' use enables me to recommend the wash-bottle described by me. It may be obtained from Messrs. Townson and Mercer.—I am, &c.,

M. H. Foye.

Crewe, December 20, 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 22, November 28, 1881.

Isomeric States of the Haloid Salts.—M. Berthelot.—The author finds himself led to the conclusion that the exothermic changes effected in the condition of silver iodide correspond either to polymerisation or rather to a true change of chemical function.

The Distribution of Energy by Electricity.—Marcel Deprez.—A mathematical paper which cannot be reproduced without the accompanying diagram.

Decomposition of Watery Vapour by the Electric Effluve.—MM. Dehérain and Maquenne.—The authors mention that the expression "electric effluve" does not designate a unique phenomenon, always identical with itself, but an entire series of effects, which may vary from the spark and the rain of fire to simple phosphorescence, and even electric interchanges, which do not give rise to any luminous appearance. To these various effects correspond different chemical actions; certain effluves neither determine the decomposition of watery vapour nor the combination of oxygen and hydrogen. The experiments performed seem to establish that certain electric effluves, even free from sparks, and at a relatively feeble tension are capable of decomposing water into its elements; this method of decomposition is therefore distinct from that pointed out by M. Berthelot in the case of the spark. The authors cannot yet decide if the decomposition tends towards a fixed limit.

Reply to M. Isambert's Note on Ammonium Carbamate.—R. Engel and A. Moitessier.—The authors uphold the accuracy of their experimental results against M. Isambert.

An Electrolytic Dosometer serving to Measure the Intensity of the Current during the Medical Application of Electricity.—J. L. Pulvermacher.—This instrument is intended to measure, in cubic millimetres, the gases obtained by the decomposition of water during a given time. It is composed of a glass tube voltameter, in the bottom of which are melted the two electrodes of platinum wire. A second glass tube of 0·001 metre is soldered to the upper extremity. The gases produced by the decomposition of the water collect in a kind of chamber contrived at the bottom of the graduated scale. They can escape only by means of an aperture, which can be either closed or opened at will by means of a caoutchouc rod.

Journal für Praktische Chemie.
No. 16, 1881.

A New Method for the Electrolytic Determination of Zinc.—H. Reinhardt and Dr. R. Ihle.—The authors, after careful trial, find none of the existing methods satisfactory. They have succeeded in completely precipitating zinc from an oxalic solution, even by a feeble current, and obtaining it in a compact form, suitable for weighing. They prepare a solution of zinc sulphate or chloride as neutral as possible, and add an excess of neutral potassium oxalate till the precipitate of zinc oxalate is re-dissolved. A current yielding 90 c.c. of mixed gases per hour is strong enough to effect complete precipitation. The zinc oxalate is resolved into Zn and $2CO_2$, and the potassium oxalate into K_2 and $2CO_2$. Free oxalic acid in presence of a sufficient quantity of potassium oxalate, is not injurious, but the precipitation is much more rapid in neutral solutions. The presence of nitric acid, whether free or in combination, is objectionable. A specimen of zinc-blende was dissolved in *aqua regia*; the solution was then diluted, and all the metals of the H_2S group were precipitated by sulphuretted hydrogen. The solution, containing only zinc, iron, and manganese, was concentrated with sulphuric acid on the water-bath, oxidised with bromine water, and the zinc, along with the small quantity of manganese, precipitated as oxalate by Classen's method. The precipitate was washed, first, with a mixture of equal parts of alcohol, water, and glacial acetic acid till the solution of potassium oxalate was removed, and then with pure water till the washings no longer showed an acid reaction. The zinc oxalate, thus purified, was re-dissolved by digestion with a warm solution of potassium oxalate in excess, and the solution was submitted to electrolysis.

Communications from the Chemico-Agricultural Laboratory of the University of Königsberg.—H. Ritthausen.—These communications consist of two portions. In the first the author describes the nitrogenous principles obtained from the seed of vetches, *i.e.*, vicine, convicine, and divicine. In the second, he treats of the action of saline solutions upon the conglutine of lupins and almonds, and the legumine of beans and lentils.

Polythionic Acid contained in Wackenroder's Solution.—T. Curtius.—Wackenroder's solution consists of pentathionic acid. Under the influence of alkaline earthy carbonates it loses sulphur, and passes quantitatively into the aqueous solution of a tetrathionate. The latter, on standing, undergoes further decomposition, in which free sulphur, hyposulphites, sulphites, and sulphates appear. The ultimate products are sulphur, sulphates, and free sulphurous acid.

Action of Chlor-benzoyl upon Glycocoll Silver.—T. Curtius.—This reaction gives rise to three nitrogenous acids, the hippuric, an acid not named, $C_{11}H_{12}N_2O_4$, which can be separated from the hippuric by its total insolubility in boiling chloroform, and a third, $C_{10}H_{12}N_3O_4$, insoluble both in boiling chloroform and in absolute alcohol.

Ethylen-ethers of Phenol and of the Nitro-phenols.—A. Weddige.—The author gives an account of brom-ethylen-phenyl-ether, brom-ethylen-nitro-phenyl-ether, and certain of their derivatives, such as imido-diethylen-phenyl-ether, its hydrobromate and hydrochlorate; ethylen-phenyl-ortho-nitro-phenyl-ether, brom-ethylen-ortho-nitro-phenyl-ether, amido-ethylen-ortho-nitro-phenyl-ether, imido-diethylen ortho-nitro-phenyl-ether, benzoyl-amido-ethylen-ortho-nitro-phenyl-ether, anhydro-benzoyl-amido-ethylen-ortho-amido-phenyl-ether, &c.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., Part 5.

The Temperature of the Soil underneath Snow.—E. and H. Becquerel.—Contrary to the common opinion a thick covering of snow does not protect the subjacent soil from severe frost as effectually as does grass-turf.

State of Combination of Phosphoric Acid in the Agricultural Soil.—P. P. Deherain and Kayser.—The authors mention that phosphoric acid introduced into the soil in the state of animal charcoal soon passed into combination with alumina and ferric oxide. In cases where the addition of superphosphate was found unremunerative, a considerable part of the total phosphoric acid was found as calcium phosphate. The mud of the Nile was found to contain 2·30 grms. phosphoric acid per kilo. If as much as 0·4 per cent of phosphoric acid is present in the soil, phosphatic manures are useless.

Mechanical and Chemical Analyses of Roumenian Soils.—S. P. Radianu.—Much of the soil is similar to the black earth of Russia. The yellow diluvial soil is very suitable for vineyards.

Quantity of Plant-food in the Refuse of Different Towns.—Dr. M. Fleischer.—The Groningen compost contains on the average:—Nitrogen 0·6, potash 0·24, and phosphoric acid 0·5 per cent. The Bremen compost (pail-system):—Nitrogen 0·52, potash 0·26, phosphoric acid 0·51. The author, taking the value of nitrogen at £60 per ton, that of potash at £11, and that of phosphoric acid at £15, values the excrementitious matter of Groningen at £240 per 1000 inhabitants, and that of Bremen at £150.

Experiments on Manuring Beets.—MM. Champonnois and Pellet.—The authors have tried two manures, one based on Ville's manure and the other on the residue of the refuse from refining beet-sugar on Porion's process. The latter was richer in potash, and of course in organic matter, and gave heavier crops.

Changes in Farm-yard Manure on Prolonged Keeping.—Prof. Birner and Dr. Brimmer.—The loss of nitrogen is considerable, but almost disappears if the manure is protected against moisture. On the addition of 1 per cent kainite and 1 per cent magnesium sulphate, the nitrogen is increased by absorption from the atmosphere.

Manurial Experiments with Saltpetre on Wheat, Barley, and Oats.—Horatio Chancellor.—Saltpetre is most beneficial in dry seasons, and should be applied in successive doses.

Manurial Experiments on the Danube Moor.—F. Schaffert.—Of local interest.

Behaviour of Mould Vegetation in the Animal Body.—P. Grawitz.—One and the same fungus may vegetate harmlessly or may destroy animal organs as a malignant pathogenic parasite.

Cultivation of Hops.—M. Müntz.—The author concludes that hop manures should be especially rich in nitrogen.

Influence of Atmospheric Electricity on Growth of the Vine.—Dr. J. Macagno.—The vines experimented on yielded grapes richer in grape-sugar and poorer in acid than those growing under natural conditions.

Certain Kinds of Sugar, Optically Considered.—Dr. Schmöger, Prof. Erdmann, Dr. E. Meissl, Dr. Kiliani.—This paper does not admit of useful abstraction.

Vol. x., Part 6.

Relations between Dust, Fog, and Clouds.—J. Aitken.—A paper read before the Royal Society of Edinburgh.

The Oxygen of Natural Waters compared with their Proportion of Organic Matter.—T. Weyl and X. Zeitler.—The oxygen was determined by Schützenberger's method—titration with sodium hydrosulphite in an atmosphere of hydrogen. The organic matter was determined by Kubel's process. In most of the samples examined an increase of organic matter was attended by a decrease of gaseous oxygen, but the quantity of the latter forms no standard for the goodness of the water.

The Black Earths of the Governments Ulfa and Samara.—Prof. C. Schmidt.—Examination of a number of samples of soil.

Manuring with Potash Salts.—Adolf Mayer.—A lengthy memoir, not capable of useful reproduction.

The Value of Different Forms of Reverted Phosphoric Acid compared with the Soluble Phosphoric Acid of Superphosphates.—Prof. M. Maercker.—In general, precipitated phosphate of lime appears of equal value with superphosphates with an equal quantity of soluble phosphoric acid. Root crops form an exception, as in them soluble phosphoric acid gives a somewhat better return. In light soils the precipitated phosphate was found much superior. Precipitated aluminium phosphate is of the same value as the calcium phosphate.

Utilisation of Certain Articles of Food in Human Digestion.—Max Rübner.—The proportion of matter assimilated from different kinds of food varies greatly. Of the nitrogenous matter in fresh meat and eggs only 2·5 to 2·7 per cent is rejected; in milk 7 to 12 per cent; in peas, beans, &c., 10·5 per cent. The author maintains that a healthy body can scarcely be formed and upheld with vegetable matter alone.

Areometric Method for Determining the Percentage of Fat in Milk.—Prof. Soxhlet.—The principle of the method is as follows:—If milk is shaken up with ether and potassa lye, the ether dissolves the fat of the milk, and on standing forms a layer on the surface of the liquid. The more fat is dissolved the greater is the specific gravity of this ethereal liquid.

Composition of the Cell-Contents of Different Parts of Grapes with Reference to the Yield of Must.—E. Mach and K. Portele.—The author has examined the relative distribution of sugar and acid in different parts of the berry.

Studies on Blue Milk.—Dr. F. Neelsen.—"Turning blue" is a morbid change which occurs in milk under the action of a specific contagium which is capable of producing a similar change in the milk of other animals and in certain other substances such as boiled potatoes, rice, and vegetable caseine. It does not extend to animal albumen or chemically pure caseine. "Blue" milk possesses no poisonous properties.

Justus Liebig's Annalen der Chemie, Band 210, Heft 1.

Meta-iso-cymol.—Dr. Werner Kelbe.—A bulky memoir, quite incapable of useful abridgment.

Communications from the Chemical Laboratory of the University of Graz.—These consist of a memoir by Karl Garzarolli-Thurnlackh, on the action of zinc-ethyl and zinc-methyl upon the chlorinised aldehyds. As a specimen of these bodies, the author has selected chloral, which by the action of zinc-ethyl was reduced to the

corresponding alcohol, trichlor-ethyl-alcohol. The action of zinc-methyl was different, the chief product being a compound $C_2H_5Cl_3O$, with the examination of which the author is still engaged.

Communications from the Chemical Laboratory of the University of Erlangen.—These consist of memoirs on cotarnine and codeine, both by E. von Gerichten.

Alkylen Substituted Amidic Acids.—Hugo Schiff.—The author has examined isobutylen-amido-benzoic acid, isoamyliden-amido-benzoic acid, œnanthamido-benzoic acid, benzylen-amido-benzoic acid, and isatamido-benzoic acid.

Aldehydo-disulphites of Aminic Acids and Amines.—Hugo Schiff.—A study of benzaldid-amido-benzoic disulphite, œnanthol-amido-benzoic disulphite, œnanthoglycocoll disulphite, benzaldid-glycocoll disulphite, glycosalicyl-glycocoll disulphite, glyco-salicyl-sodium disulphite, œnanthol-leucin disulphite, glyco-salicyl-leucin disulphite, and œnanthol-anilin-anhydro-disulphite.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, September 15, 1881.

Absorption of the Ultra-Violet Rays of certain Media.—M. le Comte de Chardonnet.—A solar ray reflected on the metallic mirror of a heliostate traverses a narrow slit and an objective of quartz and Iceland spar. It is then decomposed by a prism of Iceland spar, and its spectrum is projected upon a photographic plate or a fluorescent screen. In this manner a spectrum is obtained the principal rays of which are very distinct. When this arrangement is regulated there is interposed before the slit a quartz trough with parallel surfaces, half filled with the liquid to be examined. In this manner there are projected upon the screen two juxtaposed spectra, one being the normal solar spectrum, whilst the other is the absorption-spectrum of the substance in question.

No. 3, September 22, 1881.

Electric Motors.—A description of the motors of MM. Trouvé and Marcel Deprez.

Thermic Equilibrium in Chemical Actions.—Dr. Donato Tommasi.—Not adapted for abstraction.

No. 5, October 6, 1881.

Formation of Colouring-matters by Electro-Chemical Means.—This subject will be noticed at length.

Galvanic Elements.—Elements composed of simple bodies, one of which is iodine or bromine, manifest a perfectly constant action, and their electromotor forces correspond exactly to the thermic values developed in the course of chemical reactions, so that their action cannot be ascribed to an electrolyte contained in the bromine or iodine. The elements show no trace of polarisation.

No. 6, October 13, 1881.

According to the *Revue Medicale*, M. Dartigues has succeeded in curing three cases of hydrophobia by enclosing the patient in a heated chest, and making punctures in the skin with pilocarpine subnitrate.

Electric Motors: The Trouvé Motor.—H. Valette.—This extensive paper requires the illustrations by which it is accompanied.

No. 8, October 27, 1881.

This number contains no chemical matter with the exception of a paper by M. Gerber, giving a historical survey of chemical theories.

Moniteur Scientifique, Quesneville.
October, 1881.

Electric Exhibition at Paris.—Under this head is given a comparative table of French and English weights and measures, and the principal electric unities.

MISCELLANEOUS.

South London School of Pharmacy.—The prizes were presented to the following successful competitors in the Lecture Room of the institution on December 17, 1881. Senior Chemistry—Medal, E. John Bull; Certificate, Herbert Shaw. Junior Chemistry—Medal, W. T. Mignot Tucker; Certificate, Walter Lloyd. Botany—Medal, Clement Caldecot; Certificate, F. E. Tozer. Materia Medica—Medal, H. Hardy White; Certificate, W. T. M. Tucker. Practical Pharmacy and Dispensing—Medal, Frederick E. Tozer; Certificate, C. Caldecot.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Stearine Candles.—Can any reader inform the writer where the best work is to be had treating upon Stearine Candle Making, with recovery of glycerin.—R. I, T.

MEETINGS FOR THE WEEK.

TUESDAY, Dec. 27th.—Royal Institution, 3 p.m. "The Sun," by Prof. R. S. Ball.
THURSDAY, 29th.—Royal Institution, 3. "The Moon," by Prof. R. S. Ball.
—— London Institution, 7.
SATURDAY. 31st.—Royal Institution, 3. "Mercury, Venus, and Mars," by Prof. R. S. Ball.

ERRATA.—P. 288, col. 2, line 20 from top, read sulpho-benzene-azo-dimethyl-*aniline* (not *amine*)—$(SO_3Na)C_6H_4-N_2-C_6H_4N(CH_3)_2$.

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THE CHEMICAL NEWS.

VOL. XLIV. No. 1153.

ON β-LUTIDINE.*

By C. GREVILLE WILLIAMS, F.R.S.

IN the *Bulletin of the Chemical Society of Paris* for June 5, 1880, there appears a notice of a paper read before the Russian Chemical Society, by MM. Boutlerow and Wischnegradsky, in which they state, among other things, that by the action of alkalies on cinchonine they had obtained quinoline (chinoline) almost pure, and a volatile colourless liquid alkaloid boiling constantly at 166°, having the formula C_7H_9N, and which they say appears to be identical with the base obtained by me in distilling cinchonine with potash, and also with the lutidine of Anderson. Of the identity of the base obtained by them with β-lutidine there can be no doubt, the boiling-point (166°) given by them being to half a degree the mean of the range (163° to 168°) given by me in my "Researches on Isomeric Alkaloids."†

With regard to the identity which they assume between lutidine and β-lutidine, it is evident that they have not seen my paper last quoted, or they would hardly have ignored the mass of facts which I have adduced to prove the isomerism, and not identity, of the two bases.

In the *Bulletin of the Chemical Society of Paris*, Nos. 5 and 9, for September 5, 1880, p. 210, M. W. Oechsner de Coninck publishes an investigation on the lutidine, collidine, and parvoline obtained as above from cinchonine, his only reference to my work being to the *Ann. Chim. Phys.*, xlv., p. 488,‡ in which he says that I have shown the presence of a base possessing the composition of lutidine. He then proceeds to give analyses, density, and vapour-densities of β-lutidine, apparently unaware that they were simply repetitions of what I had done many years before. I gave the analysis of the base and the platinum salt in the *Trans. Roy. Soc. Edin.*, previously quoted. I also gave the analyses of the platinum salt of collidine in the same paper. The specific gravity of β-lutidine at 0° was given by me in my "Researches on Isomeric Alkaloids" as 0·9555; M. de Coninck makes it 0·5035 at the same temperature. M. de Coninck gives the vapour-density as determined in Von Meyer's apparatus as 3·80; I gave it as 3·65 in two experiments exactly agreeing with each other, and also made in Von Meyer's apparatus.‖ The formula C_7H_9N requires 3·699. In my paper "On Isomeric Alkaloids" I gave as the result of a determination by Dumas's method 3·787. M. de Coninck also states as a new result that the platino-chloride of the lutidine from cinchonine is modified by hot water, losing two molecules of hydrochloric acid. The extraordinary difference between the decomposability of the platinum salts of lutidine and β-lutidine on boiling with water, with evolution of hydrochloric acid, was one of the numerous illustrations of the isomerism of the two bases which I adduced in my "Researches on Isomeric Alkaloids" seventeen years ago. The tone of M. de Coninck's papers shows that he believes his results to be entirely new. I mention the above facts partly because they *are* facts, but chiefly as showing that other chemists are working on β-lutidine, and that it therefore becomes necessary to publish my more recent experiments somewhat earlier than I should otherwise have done.

The preparation of β-lutidine in a state of purity is a work of much labour. On distilling cinchonine with hydrate of potassium a mixture of at least ten alkaloids is obtained, and the β-lutidine has to be separated by fractional distillation. I have, however, prepared for the purposes of this investigation probably the largest quantity of the base that has yet obtained—rather more than half a pint.

Action of Sodium upon β-Lutidine.

I found that by the action of sodium upon chinoline it became polymerised with the formation of a body having the composition of dichinoline. This substance forms a crystalline hydrochlorate, having, when freshly prepared, a magnificent scarlet colour.* The hydrochlorate of dichinoline dyes silk a brilliant but fugitive orange colour. This reaction, namely, the formation of a coloured hydrochlorate from a colourless oily base, being probably unique, it became desirable to ascertain how β-lutidine would behave under similar circumstances.

Fragments of sodium were added to β-lutidine in the cold; they acquired a brilliant yellow colour, and had exactly the appearance of pieces of metallic gold. The mixture was then warmed until the sodium melted; it was then removed from the lamp. A violent reaction ensued, and the whole turned greenish black by reflected light, and yellowish brown by transmitted light. The product was left until the next day, and was then boiled for five minutes; it thickened, and, on being poured into water, yielded a heavy brown oil. No pyrrol was formed. Excess of hydrochloric acid being added, the oil dissolved, forming a brown solution; this was fractionally precipitated with solution of platinic chloride. Six precipitates were obtained; the first was pale brown, the second fawn coloured, the third a paler fawn, the fourth Naples yellow, the fifth sulphur yellow. The last only was distinctly crystalline under the lens. If put in a wet state into the water oven they melt, but if first dried over sulphuric acid the desiccation may be completed without fusion. The platinum was determined separately in the first four precipitates; the fifth and sixth were so small in quantity that they had to be mixed.

Number of Precipitate.	Percentage of Platinum.
I...	25·28
II...	24·82
III...	26·40
IV...	27·57
V. and VI.	30·28

The second precipitate, in its percentage of platinum, agees with the formula for the platinum salt of the hydrochlorate of di-beta-lutidine containing 2 molecules of di-beta-lutidine, the formula being—

$$2(C_{14}H_{18}N_2)HCl.PtCl_4,$$

or, of a still higher polymer, in which case the formula becomes—

$$C_{28}H_{36}N_4.HCl.PtCl_4;$$

whichever formula we adopt, the percentage of platinum required is 24·61, which agrees closely with the experimental number. The other precipitates were probably mixtures of this salt with the platinum salt of di-beta-lutidine—

$$C_{14}H_{18}N_2.HCl.PtCl_4,$$

which requires 33·53 per cent of platinum.

A second preparation was then made, but the oil obtained on treating the crude product with water was distilled; the boiling-point varied from 180° C. to a temperature above the range of the mercurial thermometer. Four fractions were received, the fourth, which distilled at and above 300°, was dissolved in hydrochloric acid, and fractionally precipitated with platinic chloride.

* A Paper read before the Royal Society, December 15, 1881.

† *Proc. Roy. Soc.*, vol. xiii., p. 305, June, 1864.

‡ This is a *precis* of my paper, "On the Volatile Bases produced by Destructive Distillation of Cinchonine," *Trans. Roy. Soc. Edinburgh*, xxi., part 2, April, 1855.

‖ CHEMICAL NEWS, March, 1879.

* CHEMICAL NEWS, March 1, 1878; *Proc. Roy. Soc.*, No. 211, 1881.

Number of Precipitate.	Percentage of Platinum.
I.	lost
II.	24·69
III.	26·48
IV.	29·60

The second precipitate, therefore, afforded almost exactly the numbers required for the salt $C_{28}H_{36}N_4.HCl.PtCl_4$, and the others were probably mixtures of the kind I have indicated above. It is possible that the fourth precipitate had the composition shown by the formula—

$$C_{14}H_{18}N_2.3HCl.PtCl_4,$$

which would require 29·84 per cent of platinum; I propose to settle this question by further experiments.

During the precipitation of the platinum salts from the distilled base the solution became of a brilliant but fugitive scarlet colour. It is evident from the above numbers that the oil of high boiling-point had the same general character as the crude mixture first examined.

Sodium amalgam, although it so readily polymerises chinoline,* was found to be almost without action on β-lutidine.

The action of sodium was then tried upon β-lutidine dissolved in toluene; two products were obtained, one solid, the other liquid. The solid substance on being dissolved in hydrochloric acid, and fractionally precipitated as before, gave two precipitates.

Number of Precipitate.	Percentage of Platinum.
I.	25·30
II.	33·33

The fluid portion treated as before gave—

Number of Precipitate.	Percentage of Platinum.
I.	26·14
II.	30·69

The results, while proving that β-lutidine is polymerised by the action of sodium, show also that at least two substances are formed, and that separation is not easily effected by fractional precipitation with platinic chloride. It will be seen that the second precipitate from the hydrochlorate of the solid base gave for the platinum a number almost exactly agreeing with that required for the platinum salt of di-beta-lutidine, $C_{14}H_{18}N_2.HClPtCl_4$, which requires 33·53 per cent of platinum.

Compound of β-Lutidine with Nitrate of Silver.

I have shown in my paper "Researches on Isomeric Alkaloids,"† that β-lutidine combines *directly* with platinic chloride; it does the same with nitrate of silver.

When β-lutidine is added to an aqueous solution of nitrate of silver, a white curdy precipitate is thrown down; it dissolves in alcohol, and is re-precipitated by water as a glittering mass of snow-white crystals. These latter crystallise readily from alcohol in beautiful stellar groups. On analysis the following numbers were obtained:—

	Experiment.	Calculation.		
Carbon	50·97	51·32	C_{21}	252
Hydrogen	5·98	5·50	H_{27}	27
Nitrogen		11·41	N_4	56
Oxygen		9·78	O_3	48
Silver	21·03	21·99	Ag	108
		100·00		491

agreeing with the formula—

$$3(C_7H_9N).Ag.NO_3.$$

Compound of Hydrochlorate of β-Lutidine with Chloride of Uranyl.

On mixing solutions of hydrochlorate of β-lutidine and chloride of uranyl, a beautiful yellow salt is formed; it gave the following numbers:—

	Experiment.	Calculation.		
Carbon	26·90	26·67	C_{14}	168
Hydrogen	3·39	3·17	H_{20}	20
Nitrogen		4·44	N_2	28
Chlorine		22·54	Cl_4	142
Uranium		38·10	Ur_2	240
Oxygen		5·08	O_2	32
		100·00		630

agreeing with the formula—

$$2(C_7H_9NHCl).Ur_2O_2Cl_2.$$

Compound of Sulphate of β-Lutidine and Sulphate of Uranyl.

On mixing sulphate of uranyl with sulphate of β-lutidine a yellow mass consisting of small crystals is formed on long standing. The substance was dried at 100°, and burnt, with the annexed result:—

	Experiment.	Calculation.		
Carbon	19·10	19·27	C_{14}	168
Hydrogen	2·54	2·29	H_{20}	20
Nitrogen		3·21	N_2	28
Sulphur		14·68	S_4	128
Uranium		27·52	Ur_2	240
Oxygen		33·03	O_{18}	288
		100·00		872

The above numbers agree with the formula—

$$2(C_7H_9N)H_2SO_4.Ur_2O_2.3(SO_4)$$

Picrate of β-Lutidine.

When β-lutidine is added to a strong boiling solution of picric acid, most of the salt formed settles out as an oil, owing to its insolubility and fusibility, but it becomes a solid crystalline mass on cooling. On re-dissolving the solid in boiling water, and allowing the solution to cool, the vessel becomes filled with brilliant yellow needles. They were burnt with oxide of copper, with the necessary precautions, and gave the following numbers:—

	Experiment.			Mean.	Calculated.		
Carbon	46·77	46·75	46·80	46·77	46·43	C_{13}	156
Hydrogen	4·11	4·16	3·94	4·07	3·57	H_{12}	12
Nitrogen					16 67	N_4	56
Oxygen					33·33	O_7	112
					100·00		336

The formula is therefore—

$$C_6H_2(H.C_7H_9N)3(NO_2).O.$$

Action of Chlorine on β-Lutidine in presence of Iodine.

The chlorination of β-lutidine was effected by Hugo Müller's method; for this purpose iodine was added to the alkaloid, the mixture was heated to 100°, and a current of chlorine was passed through until complete saturation. The product was a dark reddish-brown fluid, which was distilled. The portion boiling below 220° was washed with a dilute solution of hydrate of sodium, and then treated with hydrochloric acid; a viscid green substance of peculiar odour remained undissolved. On adding solution of platinic chloride to the filtered liquid, a granular precipitate was obtained; it was washed, dried, and the percentage of platinum determined: it amounted to 23·49 per cent. The formula $2(C_7H_6Cl_3N.HCl)PtCl_4$ requires 23·74. This result shows that the product is a trichlorinated β-lutidine retaining the basic properties of the original alkaloid.

Use of Electricity for Purifying Porcelain Paste.—Ferruginous matter is removed by passing the paste in a very liquid state between the poles of powerful electromagnets.—*Les Mondes.*

* *Proc. Roy. Soc.*, No. 211, 1881.

† *Proc. Roy. Soc.*, vol. 13, p. 508. There is a misprint in this paper, the formula for the direct compound of β-lutidine with platinic chloride is given as $C_7H_9N.PtCl$, it should have been $C_7H_9N.PtCl_2$; or, in modern notation (Pt=198) $2(C_7H_9N)PtCl_4$.

DETECTION OF OLEOMARGARINE.*

By P. CASAMAJOR.

In the *Moniteur Scientifique* for April, 1881, is an article on butter analysis, in which are given the processes used at the Municipal Laboratory attached to the Prefecture of Police in Paris, for the detection of foreign fats in butter. This is followed by an account of an areometric method, used for the same purpose and based on the difference of density between butter and the fats with low melting-point, extracted from tallow, which are made to resemble genuine butter, and which are known under the commercial name of *Oleomargarine*.

The sale of oleomargarine has become so extensive in this country that a purchaser of butter is never sure whether he is getting true butter or its imitation. In view of this fact, I have thought it useful to give a process, based on the difference of specific gravity between butter and oleomargarine, of such simplicity that it can be easily applied by any person having rudimentary ideas of manipulation.

Processes of this character are those which can be used with greatest efficiency to check adulterations. I have, in previous communications, given such processes for the detection of starch sugar mixed with cane sugar, and for the detection of starch sugar syrup mixed with sugar house syrups.

Although my concern is principally with the difference of density between butter and oleomargarine, I propose to very briefly call attention to the processes used at the Municipal Laboratory of the Prefecture of Police, as these show important differences in chemical composition between true butter and its adulterant, which confirm the difference in the specific gravity. Such an important character as the specific gravity would not differ to any marked extent without a corresponding diversity in the composition of the two substances.

One process used at the Municipal Laboratory is the following: the sample of butter to be tested is melted, so as to separate water, salt, &c., which are deposited, and a certain amount of scum, which comes to the surface. Of the clear melted fat, under the scum, about 3 or 4 grms. are taken and saponified by 1 or 2 grammes of potassic hydrate. The fat and potassa should be mixed with 50 c.c. of alcohol. In about five minutes the saponification is complete, and the cautious addition of water should not produce any turbidity. If any takes place, the operation must be begun anew. The soap formed is afterwards decomposed with weak sulphuric acid, and the insoluble fat acids are collected and weighed. The result of a great number of experiments is that in butter the percentage of fat acids thus obtained is usually 86·5 to 87·5 per cent, and that sometimes it is as high as 88 per cent. In animal fats from tallow the percentage of insoluble fat acids is 95½. The difference $95\frac{1}{2} - 87\frac{1}{2} = 8$ per cent, is attributed to the absence in tallow of volatile and soluble fat acids which exist in butter.

Another process is given in which the result is obtained volumetrically, by estimating the quantity of potassa used in saponifying the fat. One gramme of butter requires 225 to 232·4 c.c. of potassa solution, while 1 grm. of tallow, or other animal fat of the same nature, requires from 195 to 197 grammes of the same potassa solution.

Mr. Charles Girard, director of the Municipal Laboratory, considers as adulterated any butter requiring, for saponification, less than 221·5 c.c., of the potassa solution. In some unfavourable cases this volume may represent nearly 30 per cent of foreign fat.

The method for detecting the difference between butter and oleomargarine by the difference of specific gravity is one proposed by Messrs. Leune and Harburet.

The butter to be tested is first melted so as to separate the pure fat from water, salt, &c. The clear melted fat is placed in a cylinder, heated by the vapour escaping from a water-bath, kept boiling, but no part of the cylinder is to be in the boiling water. I understand that by heating in this way, the temperature of the melted fat remains at about 93° C. To determine the density of this fat an areometer is placed in it. This areometer is graduated in such a way that, in butter, it will sink to the lowest mark of the scale, while oleomargarine corresponds to the highest point in the graduation. The intervening space is divided into ten equal parts, each one of which corresponds to one-tenth of oleomargarine, mixed with butter. More than 600 experiments made by Messrs. Leune and Harburet with artificial mixtures show that, within an approximation of 10 per cent, the instrument gives correct results.

Soon after this areometric method was published, it was announced that the difference of the specific gravities of butter and of oleomargarine was too slight to distinguish the one from the other. As Messrs. Leune and Harburet had not stated what the specific gravity of each was, it was impossible to judge of the truth of this statement, and it became interesting to ascertain the facts of the case. The following process is the result of my attempts to determine the specific gravities of butter and of oleomargarine. I chose in the first place to ascertain the specific gravity of each at 15° C, which is the usual temperature for such determinations. The process consisted in finding for each a liquid in which, at 15° C, a portion of butter or of oleomargarine, freed from impurities by previous melting and containing no air bubbles, would remain in equilibrium in any portion of the liquid, without any tendency to rise to the top or sink to the bottom. The readiest liquid for this purpose was a mixture of alcohol and water, as this is easily prepared and it has no dissolving action on the fats to be tested. As the density of the liquid in which a body remains in equilibrium is the density of the body itself, the problem was narrowed down to finding the difference of density between two mixtures of alcohol and water of different strengths. It was found that pure butter, at 15° C. would remain in equilibrium in alcohol of 53·7 per cent. This corresponds to specific gravity 0·926. This butter was obtained from a gentleman, at whose country place the butter was made. I obtained oleomargarine from melted warm beef suet by pressure. At a temperature of 25° C. this expressed fat had the consistency of butter. The alcohol which at 15° C. would hold it in equilibrium had a strength of 59·2 per cent, which corresponds to a specific gravity of 0·915.

The question of the possibility of distinguishing butter from oleomargarine becomes equivalent to the possibility of distinguishing alcohol of 53·7 per cent., from alcohol of 59·2 per cent. As this difference is 5·5 degrees of Gay-Lussac's alcohometer, it is very evident that the specific gravity is a sufficient character for distinguishing butter from oleomargarine. This difference may appear more clearly to persons not familiar with alcohometry by stating that it is the difference between 0·926 specific gravity and 0·915.

By means of the tables of Gay-Lussac and of Tralles,* it is a very easy matter to prepare alcohol of the required strength at any temperature, to be kept in bottles for future use.

As the expansion of fats is different from that of alcohol, it is advisable to bring the alcohol to 15° C. when making an observation, which can be easily done by any one provided with a thermometer.

To deliver the sample of fat on the alcohol, I have found that the best plan is to melt the fat and let a large drop of it fall into the liquid. The fat should be melted in a little spoon or a little scoop, and the drop should be delivered by bringing the spoon or scoop close to the surface of the alcohol. It requires a little practice to do this neatly, so as not to get an air bubble in the ball of melted fat. When an air bubble becomes imprisoned in the fat,

* Read before the American Chemical Society, Sept., 1881.

* See the excellent tables of Prof. McCulloh.

I have had no difficulty in removing it with a strip of paper, while it lies on top of the alcohol. Sometimes the globule of fat only partially sinks in the alcohol; the top of it becomes flat and remains exposed above the liquid. A slight tap on the side of the glass is then generally sufficient to form a wave and sink the globule.

If we take alcohol at 56½ per cent, which represents equal volumes of alcohol of 53·7 per cent, and of 59·2 per cent, and if we deliver on the surface of this alcohol a globule of melted butter and one of oleomargarine, the butter will sink to the bottom and the oleomargarine will remain at the top, while the two globules are still warm and liquid. Afterwards, if the alcohol has a temperature of about 30° C. the butter will become solid, while the oleomargarine may still remain liquid. Then the butter will rise to the top of the alcohol, which is due to the expansion of butter on solidifying. If the alcohol be then kept for a few minutes at 15° C. the oleomargarine will become opaque and remain at the top while the solid globule of butter will sink to the bottom.

If instead of taking alcohol of 56 per cent we use alcohol of 59·2 per cent, oleomargarine will remain on top and butter will sink to the bottom at all temperatures above 15° C. At 15° C. oleomargarine will remain in equilibrium in any portion of the liquid in which it may be placed.

If oleomargarine was always sold pure, the foregoing indications would be sufficient to distinguish it from butter, but the oleomargarine found in the market is always more or less mixed with true butter to improve its taste and appearance. This being the case, alcohol of 59 per cent is not the proper liquid to detect oleomargarine. We should use alcohol of 55 per cent and consider as oleomargarine any so-called butter which will not sink to the bottom in alcohol of this strength at 15° C. This is founded on the fact that not more than one-third of butter is ever mixed with oleomargarine to improve its taste and appearance.

Bearing in mind the experiments of Messrs. Leune and Harburet, already cited, the proportion of butter and of oleomargarine in a mixture could be easily detected by finding what strength of alcohol will hold in equilibrium at 15° C. a globule of fat under examination. As the difference of 59·2 and 53·7 is 5·5, the proportion of oleomargarine is the difference between the strength of the alcohol and 53·7, divided by 5·5, or more conveniently multiplied by 0·18. If the alcohol required to hold a globule of fat in equilibrium at 15° C. has a strength of 57 per cent, then: $(57-53{\cdot}7) \times 0{\cdot}18 = 3{\cdot}3 \times 0{\cdot}18 = 5{\cdot}95$, or say six-tenths of oleomargarine. If the alcohol had a strength of 58, then $58-53{\cdot}7 \times 0{\cdot}18 = 4{\cdot}3 \times 0{\cdot}18 = 7{\cdot}72$, or about eight-tenths of oleomargarine.

The proportions of butter and oleomargarine in a mixture may be also determined without the aid of an alcohometer, by using the two solutions of 53·7 per cent and of 59·2 per cent. These may be placed in graduated glasses and poured cautiously into a third glass, until an alcohol of sufficient strength is obtained to keep in equilibrium a globule of the fat under examination at 15° C.

The relative volumes of the two solutions used in making the mixture give the proportions of butter and oleomargarine.

CHEMICAL METHODS FOR ANALYSING RAIL-STEEL.*

By MAGNUS TROILIUS, Chemist to C. P. Sandberg, London.

(Continued from page 300.)

Magnesia Methods.—In some laboratories it is usual to re-dissolve the phospho-molybdate obtained, and then to precipitate with magnesia mixture. This is a rather slow and wasteful way of procedure, and the direct (Riley's) method seems then preferable.

In the direct method one may use at least 10 grms. of steel. The hydrochloric acid solution is reduced by means of sulphite of soda, the excess of sulphorous acid is removed by boiling, the solution is then neutralised with ammonia and bromine added, so as to oxidise about 0·3 to 0·4 grm. of iron. The sesquioxide of iron is precipitated by means of acetate of soda, and the whole of the phosphorus in the steel is supposed to be precipitated along with it.

The precipitate is filtered off and dissolved in hydrochloric acid, about 13 grms. of citric acid are added, and the solution is neutralised with ammonia; 20 to 30 drops of magnesia mixture are then added, and some ammonia. The whole should then be left for two days, and be stirred up now and then during that time before it is finally filtered. The precipitate is washed with ammoniacal water, ignited, and weighed.

It is difficult to see where the advantage of using this method would lie, as compared with the direct weighing of the phospho-molybdate. The ignited phosphate of magnesia contains 27·95 per cent of phosphorus, and an error in weighing must have, therefore, a serious influence on the result, unless a very large quantity of the steel be used. But altogether, the magnesia method requires much more time, skill, and labour than the molybdic method. To this should be added the statement by Professor Eggertz, that it is exceedingly difficult to obtain the reagents used in the magnesia method free from phosphorus, whereas in the molybdic acid method it is only the nitric acid which may contain phosphorus. Too high results are, therefore, frequently obtained by the magnesia method.

In conclusion I may say that the above-described brushing method, which I use daily, has given very accurate results, as the same borings have been checked by some of the leading chemists of the day. As to the time required, if several analyses are performed at the same time, and suitable arrangements made, two or three, or even more, results may be obtained in a day.

Silicon Determination.—For determining silicon in rail steel I use the aqua-regia and the sulphuric acid methods. The former has been sufficiently described in connection with the phosphorus determination, and I will here, therefore, only mention the principal details of the latter.

For each gramme of steel I use 14 c.c. of a mixture of sulphuric acid and water, in the proportion of 1 of sulphuric acid to 6 of water. If I wish to estimate the silicon only, no oxidising of the solution is necessary, and I have only to boil (with exclusion of the air as far as possible) until all is dissolved, and then completely evaporate the water so as to render the silica insoluble. The white salt is then taken up with hot water and a few drops of strong hydrochloric acid, and the silica filtered off and washed with hot water containing 5 per cent. of nitric acid.

If manganese is to be estimated in the solution obtained the solution should be boiled with a few cubic centimetres of nitric acid for about one-quarter of an hour before evaporating down. After dissolving the salt in water and hydrochloric acid, boiling should be continued for another quarter of an hour before filtering off the silica, so as to insure the manganese being converted to manganous oxide. The silica must, in this case, be washed, first with ordinary cold water, and then with the nitric acid water, which should flow into a separate beaker and not into the first filtrate, where it might produce a higher state of oxidation of the manganese.

I find that the aqua regia and the sulphuric acid methods yield results which are quite uniform and concordant. The sulphuric acid method can be quite as rapidly used as the aqua-regia method by means of the hot-plate. Two years ago I worked this method in a steel laboratory in Wales, and the chemists at the place took

* Read before the American Institute of Mining Engineers, October, 1881. From the *Journal of the Franklin Institute.*

such a liking to it on account of the absence of the disagreeable fumes, which are evolved in the aqua-regia method, that they started working it for the daily determination of silicon in their pigs. At the present time they use the sulphuric acid method exclusively, and are by practice enabled to work it quite as rapidly as the aqua-regia method. Besides being a neater method, the sulphuric acid process effects no inconsiderable economy in daily practice, where otherwise large quantities of aqua-regia must be consumed.

When using acid water, as in the sulphuric acid method, or strong hydrochloric acid, as in the aqua-regia method, for washing the silica, I make no deduction for filter-ash. The best Swedish filter-paper dees not leave any practically estimable quantity of ash when treated in that way. Otherwise a deduction is made according to Eggertz's formula:

$$\text{Ash, grms.} = 0{\cdot}0001\ D_2,$$

D being the diameter of the filter.

Manganese Determination.—For determining manganese in rail steel I use the acetate of ammonia and bromine process, with *final additions of ammonia*, as usual in English and Welsh steel laboratories. In Germany, the method with acetate of soda and bromine or chlorine, and *no final addition of a strong base*, is used, and in Sweden the acetate of soda and bromine method, in accordance with Prof. Eggertz's directions. In describing my mode of operating, I will also try to point out the great difference between the method with *ammoniacal salts and bromine and ammonia combined*, and the methods with *fixed alkaline salts*; and to show what are the precautions to be taken in each case to attain accuracy.

Bromine and Ammonia Process.—3 grms. of steel are dissolved in a flask of 1 litre capacity by aid of aqua-regia; the solution is boiled down, and finally dried. The mass is then dissolved in hydrochloric acid by boiling; water is added to about 750 c.c. volume, and the solution neutralised with ammonia or carbonate of ammonia. If too much ammonia is added, care must be taken immediately to add some hydrochloric acid and to boil for a short time, so as to prevent manganese being precipitated. When neutralising is completed add 20 to 30 c.c. of strongly concentrated, thick acetate of ammonia, and boil until you see the precipitate settle clear after lifting the flask off from the lamp. If the supernatant liquid will not become clear, add cautiously a few drops of strong ammonia (0·88), shake the flask, and boil for a moment again. In this way you are certain to obtain a clear supernatant liquid; but you must be very careful not to add too much ammonia, as the manganese may then be partly precipitated as hydrated oxide. After settling, the clear liquid is passed through a filter of ten inches diameter into a large flask, and finally the precipitate of basic acetate of oxide of iron is poured on to the filter and the remainder of the fluid allowed to filter well off. When no more drops seem to come from the funnel the basic acetate is washed down into the first flask by means of boiling water, and hydrochloric acid is added. The flask is well shaken and heated to boiling, in order to insure the remainder of the manganese being present only as manganous oxide. Neutralising and precipitation is then repeated as before, and the filtrate added to the first one obtained. For rail steel I find two precipitations like these quite sufficient, the manganese in such steels rarely exceeding 1 per cent. But for spiegeleisen, ferro-manganese, &c., it is certainly desirable to re-dissolve twice, as the more manganese there is in the substance the more of it will be retained in the iron precipitate. Anyhow, it should be borne in mind that a good boiling is necessary after every re-solution, in order to convert the manganese to *manganous* oxide.

The collected filtrates contained in the large flask are then allowed to cool (this takes only a short time, the first filtrate cooling the second, and so on), about 4 c.c. of bromine are added and the flask well shaken, so that the fluid may be well saturated with bromine. It is the safest always to add so much bromine as to have quite a reddish colour in the solution. Ammonia (0·88) is then added in excess, and the flask well shaken. At first the solution generally becomes quite colourless, but after continued shaking the brown colour begins to be more and more evident, and soon the oxide of manganese separates in lumps. It is then boiled for a few minutes, the precipitate allowed to settle and then filtered off, washed with hot water, dried, ignited, and weighed.

It is necessary to have the solution quite cold and a large excess of bromine present when precipitating the manganese in this way. If the solution be hot a violent evolution of nitrogen gas will take place, and the manganese remains in the solution. Insufficient bromine also causes only a partial precipitation. One may write the reactions in this process as follows:—

I. *Insufficient bromine:*

$$2[MnO_2(C_2H_3O)_2] + 5Br + 8NH_3 + (x+2)H_2O = (MnO_2 + xH_2O) + MnO_2(C_2H_3O)_2 + 5NH_4Br + 2[NH_4O(C_2H_3O)].$$

II. *Sufficient bromine:*

$$MnO_2(C_2H_3O)_2 + 5Br + 8NH_3 + (x+2)H_2O = (MnO_2 + xH_2O) + 5NH_4Br + 2[NH_4O(C_2H_3O)] + N.$$

(To be continued.)

AN APPARATUS FOR THE DISTILLATION OF MERCURY IN VACUO.

By ARTHUR W. WRIGHT.

THE importance of pure mercury in many of the operations in the laboratory makes a simple and efficient means of freeing from its impurities the ordinary commercial metal, or that which has become fouled by use, an object greatly to be desired. The familiar chemical methods, aside from their inconvenience, are not entirely satisfactory, and often leave the condition of the product uncertain. Distillation in the usual way, in retorts open to the air, does not prevent contamination by oxidation, and the purity of the metal is further endangered by the liability to spurting and the possible presence of substances volatile at the boiling-point of mercury. When the process is conducted in a vacuum, however, these drawbacks are avoided, and a perfectly pure product is obtained.

A very elaborate and complete apparatus for this purpose has been devised by Professor Weinhold,* which fully satisfies all the conditions of the problem. This instrument has provisions for the maintenance of the vacuum by means of a Sprengel pump which constitutes a special part of it, with suitable arrangements for adjustment of the mercury supply, the heat from the gas burner, and the like. The devices for securing these objects, however, render the apparatus somewhat bulky and complicated in structure. A far simpler construction has been employed by Dr. L. Weber,† which, however, has no contrivance for maintaining or renewing the exhaustion, except by re-filling with mercury, and otherwise leaves much to be desired. It consists essentially of a long glass tube, bent into a U-shape, so that when filled with mercury and inverted with the ends of the tubes in vessels containing mercury it forms a double barometer, the bend of which is above the level of the metal and therefore vacuous. An enlargement at one side where the heat is applied by a small Bunsen flame gives an increased surface of evaporation. The mercury vapour condenses in the upper portion of the empty space and flows out through the other branch of the tube.

The apparatus devised by the writer is based upon Weber's plan of a double barometer tube, but with important modifications which secure substantially the

* Carl's *Repertorium für Physik*, vol. xv., p. 1.
† *Ibid.*, vol. xv., p. 52.

advantages of the more complicated system of Weinhold. The most essential portions of it are represented, in section, in the accompanying sketch, which is drawn to a scale of one-tenth that of the instrument itself. The principal member of the still consists of a single continuous piece of glass work, which, for convenience of description, may be regarded as made up of several distinct parts designated by the letters *b*, *c*, *d*, *e*, *f*, *g*, *h*.

The portion *b* is a straight, rather heavy piece of tubing, of about one centimetre exterior, and five or six millimetres interior, diameter. Its length is a little more than 76 centimetres. It is open at the lower extremity, and at the other is enlarged to an oval bulb, *c*, about 85 m.m. in diameter and 120 m.m. long. At the upper end of this is joined the portion *d*, *e*, having an interior calibre of about 15 m.m. The vertical portion next to *c* is 25 m.m., the inclined portion, *d*, 130 m.m., and the sloping part, *e*, 300 m.m. in length. The object in making *d* so long and giving it the inclined position was to prevent any globules of mercury thrown up from the bulb entering the portion *e*. But it might well be somewhat shorter, as with proper care in the application of the heat no shocks of the mercury in boiling ever occur.

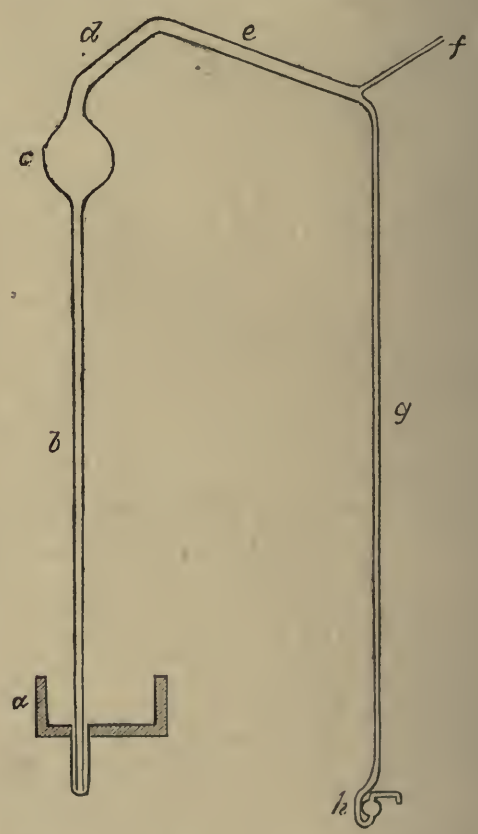
Toward the end of *e* the glass is narrowed, and, at the angle, it passes to a continuation *g*, which is a straight, vertical tube having an interior diameter of about one millimetre. The angle is so formed that the globules of mercury running down from *e* fall freely into *g* without accumulation at any point. This part of the apparatus is in fact a Sprengel pump, and the mercury as it passes out maintains the exhaustion of the whole tube at a very high point. A small tube, *f*, serves to make connection with the air-pump at the beginning of the operations. The tube *g*, at its lower end, *h*, is bent upward and a small bulb blown upon it, sufficiently large to hold enough mercury to fill *g* itself. Above the bulb the tube is bent into a horizontal direction, this part being 30 or 40 millimetres long, and then directly downward, forming the outlet for the mercury. The total length of *g* is 90 centimetres.

A cistern, *a*, serves for the reception of the metal to be operated upon. It is a wooden box 150 m.m. square, and about 60 m.m. deep. The joints are carefully fitted, and the wood oiled and then well varnished, being thus rendered quite impervious. A small well, 80 m.m. deep, for the reception of the end of the main tube, is made by inserting a thick glass tube in the bottom of the box. This arrangement, with the large area of the cistern, increases the range of adjustment of the latter, and makes it possible for several kilogrammes of mercury to pass through the apparatus before any such alteration of level in *c* is produced as to require a new supply or a readjustment.

The glass tube and cistern are mounted upon a light wooden frame, the weight of the former with its contents being chiefly sustained by an iron ring which touches the bulb some distance below its widest part. Several layers of fine wire gauze carefully fitted to the lower half of the bulb are interposed between it and the ring, forming an elastic bed, and serving also to distribute the heat. A cylinder of thin sheet copper just large enough to slip through the ring, is supported upon the latter by a narrow flange at the top. It extends downward about 60 m.m., and is pierced with a number of holes just beneath the ring. It serves to direct the heated current from the burner upon the bulb, as also to protect the flame from movements of the air, and render it steady in its action.

The heating apparatus consists of a hollow ring having upon the upper surface 12 holes 2·5 m.m. in diameter, spaced uniformly in a circle of 25 m.m. radius, and concentric with the glass tube which passes through it. The ring is fitted to the top of a common Bunsen burner, and the whole moves upon a vertical slide, with a clamp screw, by which it may be fixed at any point desired. It has been found advantageous in practice to use but six of the openings, and these all upon one side. A conical hood of sheet copper encloses the upper half of the bulb, and is prolonged by a tube of the same material, which covers the glass tube as far as the angle above *d*. The lower edge of the hood is at nearly the same level as the top of the cylinder above mentioned, and is about six centimetres wider than this, so as to project laterally some three centimetres all round. The upper portion of the copper cone and tube are wide enough to leave an interval of five or six millimetres between them and the glass. The heated gases from the holes in the cylinder, streaming through this space, envelope the bulb *c* and tube *d*, thus preventing condensation of the mercury vapour before it reaches *e*.

The cistern is mounted upon a vertical slide with a clamp screw, and can be moved up or down, the range of motion being about six centimetres. This makes it possible always to bring the mercury to the proper height within the bulb, and to suit the adjustment to the varying atmospheric pressure.



The apparatus is put in operation as follows: Connection having been established with a Sprengel air-pump by means of the tube *f*, mercury is poured into the cistern so as to cover the bottom of it to the depth of a centimetre or two. If pure mercury is at hand, the bulb at *h* may be filled with it, if not the extremity of the outlet tube is sealed or otherwise tightly stopped. As the exhaustion proceeds the mercury rises in *b*, finally reaching *c*, and if all the air were removed, it would stop at the barometric height above the surface in the cistern. The latter is adjusted so that the top of the column is a little below the centre of the bulb, *c*. When no more air can be withdrawn by the pump, *f* is sealed with a gas flame and the connection with the pump severed. The apparatus is thus exhausted once for all, as subsequently it maintains the vacuum by its own operation. The burner, previously set some distance below the bulb, is now lighted and the flame made

very small at first. The mercury soon becomes heated, vapour is formed, and after a time drops begin to fall from the interior surface of the bulb and tube above it. The flame is slowly increased and raised, until, in fifteen or twenty minutes, the vapour passes the angle at the top, and begins to condense in *e*. As the globules of mercury fall into *g* they carry with them the residue of the air, gradually filling the bulb at *h*, and later the tube *g* itself. The point of the tube at *h* is now unsealed or broken off, and the mercury issues drop by drop into a vessel placed to receive it. The operation now proceeds continuously, and the apparatus requires scarcely any attention, further than to keep the cistern properly supplied with mercury, and to remove the pure metal when necessary. The residual air is quickly removed from the tubes by the pumping effect in *g*, and after a time each drop falls with a sharp click in the tube. The construction of the part *h* makes it easy to obtain pure mercury from the very beginning of the operation, an advantage not furnished by the other forms of the apparatus mentioned.

In adjusting the height of the cistern, *a*, allowance must be made for the tension of the mercury vapour in the upper portion of the tube. The cooling effect of the condensing tube, *e*, is such that this is usually from four to six millimetres, and it rarely or never exceeds one centimetre. The temperature of vapourisation corresponding to the latter tension is less than 180°, as, according to Regnault's results, this is the temperature at which the vapour has a tension of eleven millimetres. The low temperature is of itself a matter of importance, both as regards economy in the application of the heat, and as diminishing the probability of volatilisation of any substances which the mercury may contain as impurities.

The apparatus here described, when in use, consumes from one-third to one-half the amount of gas required for an ordinary Bunsen burner. The mercury does not come into active ebullition, but vapourises quietly and entirely without shocks. The rate of distillation varies of course with the heat applied, but is from 400 to 450 grms. per hour. After the burner is once adjusted the apparatus requires no attention, and may be left to itself for hours, care being taken that the cistern contains sufficient mercury. When out of use the tubes are left with the mercury in them, remaining thus exhausted and ready for use at any time.

As the mercury in the bulb and the tube *b* retains all the impurities left behind in the process of distillation, these may at length accumulate in such quantity as to interfere with the proper operation of the apparatus, and to necessitate their removal. This is not likely to occur for a long time unless the mercury used is excessively impure. But when the removal is indispensable it may be effected either by opening *f*, allowing the mercury to descend into the cistern and thus be withdrawn, then refilling and exhausting as at first; or, more simply, by lowering the cistern until the mercury sinks below the bulb, in which case all but the small portion contained in *b* will run out into the cistern and can be drawn off by a syphon or otherwise, care being observed that it is not carried so low as to allow of the admission of air at the bottom of the tube.

The apparatus in operation has proved entirely satisfactory in every respect, and extended use of it in the laboratory has suggested no modification. As mounted upon its frame it has a height of about 125 centimetres, and the base covers a space 45 centimetres long and 33 wide. It is so light that it may readily be lifted and carried with one hand. The glass work was very skilfully constructed, after the design of the writer, by Mr. W. Baetz, of 96, Fulton Street, New York City.—*American Journal of Science.*

New Multiple Telegraph.—M. l'Abbe Laborde.—The author describes at great length an arrangement by which eight, ten, and perhaps even twelve dispatches may be forwarded at once by a single wire.—*Les Mondes.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 15, 1881.

E. W. Binney, F.R.S., F.G.S., President in the Chair.

"*On the Pronunciation of Deaf-Mutes who have been taught to Articulate*," by William E. A. Axon, M.R.S.L.

"*On Professor C. A. Bjerkness's Experiments to Demonstrate the Analogies between Electrical and Magnetical Phenomena and some Hydrodynamical Phenomena*," by William H. Johnson, B.Sc.

Among the many interesting exhibits at the Paris Electrical Exhibition, there is nothing more likely to engage the attention of the scientific observer than the simple apparatus and experiments of Professor Bjerkness, of the University of Christiania.

The apparatus consists in the main of metal spheres about one inch in diameter, and drums also an inch in diameter with indiarubber ends. These spheres and drums communicate by means of indiarubber tubes with a pair of air-pumps, which, by an ingenious contrivance, cause the spheres to oscillate and the drums to pulsate isochronously. If the two air-pump pistons go in and out at the same time, the spheres connected with them will oscillate concordantly. If, on the other hand, one piston goes in while the other comes out, the respective spheres connected with the air-pumps will oscillate in opposed phase. The same will take place with the pulsating drums.

When these spheres and drums are allowed to oscillate and pulsate rapidly in a vessel of water, they are found to attract each other if they vibrate in accord, and to repel each other if the vibrations are opposed. Nor is this all, for Professor Bjerkness, by carefully modifying his apparatus, which has been very imperfectly described above, has been able to imitate all the phenomena of magnetism and para-magnetism, but always in an inverse way.

Many phenomena of statical and dynamical electricity can also be imitated by these vibrating bodies, but likewise in an inverse manner.

The whole subject has been investigated mathematically by the Professor, and the laws which govern the attractions and repulsions of these vibrating bodies have been shown to be in accordance with his formulæ.

General Meeting, November 29, 1881.

R. Angus Smith, Ph.D., F.R.S., &c., in the Chair.

Mr. Richard Peacock, of Gorton Hall, Manchester, and Mr. Edmund Salis Schwabe, of 41, George Street, Manchester, were elected Ordinary Members of the Society.

Ordinary Meeting, November 29, 1881.

R. Angus Smith, Ph.D., F.R.S., &c., in the Chair.

The following letter from Mr. Joseph Sidebotham, F.R.A.S., was read :—

"Some few years ago, when I was at Mentone, I wrote to you concerning the aniline colours, so much used on the Continent in water-colour drawings. Since that time Holman Hunt and others have called attention to the fading of these and some other colours prepared for artists, and I hoped the practice of making and using these colours had ceased : however, I find this is not the case. A friend of mine was on his way to the south of France, and I asked him to see if these colours were still sold and used, and he tells me they are extensively, and sent me

cakes of them. He also sent the enclosed sheet of the colours on drawing-paper, half of it having been exposed to the light a fortnight, the other half covered up. He thought that by putting gum over the colours they might be made more permanent, and you will see he has put a band of gum across them: the colours exposed have faded in a great degree, some of them almost disappearing. The band of gum has retarded the fading, but the colours are even there much lighter and all the brightness gone. It is most desirable that artists should entirely give up the use of all these colours, and then the makers would cease to supply them. When we see the sad effects of a fortnight's light upon them, what can we expect to see in drawings hung on the walls of a room for a few years?"

"*On Cyclic Motions in a Fluid, and the Motion of a Vortex Ring of Varying Curvature*," by R. F. GWYTHER, M.A.

NOTICES OF BOOKS.

Handbook of the Collection Illustrative of the Wild Silks of India in the Indian Section of the South Kensington Museum. By THOMAS WARDLE. London: Her Majesty's Stationery Office.

THIS very interesting and important pamphlet reminds us on its title-page of an unfulfilled promise, or at least announcement. Some few years ago it was declared officially that the Indian Museum was only for the time being to sojourn at South Kensington, and was destined to form the nucleus of a grand Indian and Colonial Museum in a central and convenient position. These hopes have not been realised,—a return from South Kensington being apparently more difficult than the familiar "reascent" from Avernus.

The author of the work before us is well known as an eminent silk dyer and printer, and has been engaged for years in the study of the so-called "wild silks" of India with a view to their utilisation. The term wild silks is commonly applied to all kinds of silk other than that produced by *Bombyx mori*. Hitherto these silks have not been cultivated. The small and uncertain supplies which have found their way into commerce are derived from cocoons collected at hazard in the forests, but no organised and systematic attempts have been made to form plantations of the various food-trees and to rear the insects in a state of domestication. There can be no doubt that to do so, to attend to the proper collection of the cocoons, and to make use of improved machinery for reeling the silk, and for carding and spinning that from imperfect cocoons, would prove a remunerative undertaking, and, like the introduction of the cinchona and the tea culture into India, would add to the resources of that country and of the Empire at large. To give encouragement to so desirable an undertaking ought to be the task of the Indian Government. Mr. Wardle meantime has greatly improved and developed the methods of dyeing and printing these silks. From trials which he has had made in Italy it has been found possible to convert the Tusser raw silk into tram and organzine of very great fineness. It appears that this silk, the product of *Antheræa mylitta* or *paphia* and some allied species, differs from common silk in its behaviour with reagents. A neutral solution of zinc chloride, gently heated, dissolves common silk instantly, but only acts slowly upon the Tusser. In a cold solution common silk dissolves in three days, whilst immersion for a fortnight produces no effect upon the Tusser. With ammoniacal solution of copper oxide a similar difference of action is observed. Hence we may well infer, as is actually the case, that the wild silk must be the more difficult to dye. The great difficulty as far as Tusser silk is concerned lies in the bleaching process. Being naturally of a darker colour than common silk, and incapable of bleaching by means of sulphurous acid—a deoxidising agent—oxidisers were tried. M. Tessié du Motay proposed potassium permanganate, which certainly removed the brown colour, but unfortunately injured the texture of the silk. With barium peroxide he was perfectly successful. This reagent is, however, as yet too costly for very general use. The author refers to a method not yet fully developed, of presenting nascent oxygen to the silk from a liquid instead of from a solid. He mentions also that Major Coussmaker has succeeded in obtaining perfectly white Tusser silk by modifying the conditions under which the worm spins its cocoon. If his method is practicable upon a commercial scale the necessity for bleaching would be superseded. As the colours most adapted for dyeing Tusser silk, the author mentions lac, safflower, indigo, the leaves of *Phyllanthus emblica*, the calyces of *Thespesia populnea*, and the flowers of *Butea frondosa*, of Hursinghar, and of *Cedrela toona*. Eria silk has less affinity for dye wares than has common silk, and takes up a greater quantity of tinctorial matter. The author, however, has succeeded in producing on it a variety of shades which leaves nothing to be desired.

The work is enriched with illustrations of several of the most important silk-yielding insects in their different stages of growth, of their food plants, and of the machinery for reeling cocoons. Mr. Wardle has deserved well of British commerce and industry for his prolonged investigations.

A Study of the History and Meaning of the Expression "Original Gravity" as applied to Beer, Worts, and Distillers' Wash; also a full description of the Apparatus required. A practical Method for the Analysis of Fermented Liquors is also described. By J. A. NETTLETON, of the Inland Revenue Laboratory, Somerset House. London: Lamprey, *Brewers' Guardian* Office.

THE author of this work claims for the "Inland Revenue Act" of 1880 that it will make brewers more conversant with their own business than they were before. If such shall prove to be the case, it will prove a result diametrically opposite from what has occurred in chemical manufactures, with which we are better acquainted, as, for instance, soap manufacturing, glass making, and tannery. In each of these branches of industry, the removal of excise interference has led to more scientific management, to a better understanding of principles, and to their more careful and accurate application. It is possible, however, that as regards brewing Mr. Nettleton may be in the right. The author's first step is to define the term "original gravity"—hitherto a mystery not merely to the outside public, but to the vast majority of scientific men. It means, we learn, the original specific gravity of any wort, beer, or wash before yeast had been added and before fermentation had been commenced.

The principal object of the work before us is to show how this original specific gravity may be found at subsequent stages of the process. Fermentation changes the specific gravity of a saccharine liquid because the sugars present are split up into alcohol and carbonic acid, with the simultaneous production of a quantity of a carameloid body lighter than the original sugar. The soluble albumenoid matters contained in malt or grain are also in great part destroyed by the action of the yeast. These changes reduce the specific gravity of the liquid, and are technically known as attenuation. The method recommended for finding the original specific gravity of a beer is the so-called distillation process, the description of which is much too long to be quoted. Three other methods, less accurate, are also given.

In the last part of his work the author gives what, on the title-page, is styled a method for the analysis of a "fermented liquor." This term is too wide, as the process indicated would not be satisfactory in case of wines and other fermented liquors prepared from fruits. The points determined are alcohol, mineral matter, organic matter, acid, and water. Of possible adulterations no notice is

taken. It is singular how the Excise authorities still cling to the somewhat antiquated notion of "proof spirit," instead of calculating the strength of fermented liquids in absolute alcohol.

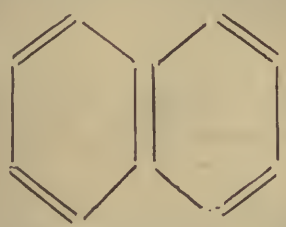
This little work will evidently be of great use to the trade and to analytical chemists. Some peculiarities of expression call at first sight for a little consideration on the part of the reader. Thus Mr. Nettleton speaks of the specific gravity "held" by a liquid, and the operation of shaking or agitating a liquid to expel gases he terms "tossing."

CORRESPONDENCE.

KEKULE'S THEORY.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xliv., p. 260, Mr. Alfred M. Pagan asks in which manner Kekulé's theory of the oscillating linkings would express the second moment of oscillation of naphthalen if the first moment were—



Though no friend of Kekulé's theory, I think it possible to imagine the structure of naphthalen in the second phase in the manner shown by—

—I am, &c.,

A Reader.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 23, December 5, 1881.

Chemical Studies on the Skeleton of Plants.—MM. E. Fremy and Urbain.—The bodies which form the skeleton of plants are chiefly pectose and its derivatives, the cellulosic compounds in their different isomeric states, cutose, and vasculose. To determine pectose, the authors converted it into pectates by the action of alkaline carbonates, and decomposed these pectates by hydrochloric acid, which precipitates pectic acid as an insoluble jelly. Among the cellulosic compounds found in plants, the authors distinguish cellulose, para-cellulose, and meta-cellulose. All these bodies possess the common character of dissolving without colouration in sulphuric acid. Their distinctive characters are:—Cellulose dissolves at once in the ammonio-cupric reagent; para-cellulose dissolves in this liquid only after the action of acids; and meta-cellulose is insoluble even after such treatment. It is dissolved by nitric acid and the hypochlorites. Vasculose forms the principal part of the vessels of plants. It is insoluble in the ammonio-cupric liquid, even after a previous treatment with acids. It resists for a long time the action of sulphuric acid, but it is rapidly attacked by oxidising agents. Cutose is the transparent membrane which covers the aërial organs of plants. It is dissolved neither by sulphuric acid nor by the cupric reagent; it is attacked by the oxidising agents, and is dissolved by dilute caustic alkali in the cold and at the ordinary pressure. Vasculose, on the contrary, resists caustic alkalies, except they are applied with the aid of heat and under pressure.

Electric Deposition of Metallic Strata of Different Colours.—F. Weil.—The author, by a process, not indicated, has succeeded in coating all metals and alloys at the common temperature, and by means of a single copper bath with a permanent and brilliant layer of various sub-oxides of copper, the chemical nature of which has not yet been studied.

Distribution of Energy by means of Electricity.—Marcel Deprez.—A mathematical paper not susceptible of useful abridgment.

Determination of the Ohm.—G. Lippmann.—A reply to M. Brillouin.

Variations of the Resistance of Electric Machines with their Speed.—E. Lacoine.—The author's experiments lead to the conclusion that these variations of resistance are explained by those of contact between the movable commutator and the friction springs.

Determination of the Illuminating Power of Simple Radiations.—MM. A. Crova and Lagarde.—The photometric process, suggested by one of the authors (*Comptes Rendus*, xciii., p. 512), pre-supposes a knowledge of the coefficients of illumination of the various simple rays which compose the light to be compared. This question the authors have investigated experimentally.

Speed of Refrigeration in Gases at Elevated Temperatures.—MM. Mallard and Le Chatelier.—Not suitable for abstraction.

Combination of Hydrogen and Oxygen under the Influence of the Electric Effluves.—MM. Dehérain and Maquenne.—It seems established by the experiments of the authors that the state of moisture of the surfaces between which the effluve is produced is capable of modifying the nature of the discharge, both in its outer aspect and in its action upon the gases. In dry apparatus the effluves never determine the detonation of the gases, but their gradual combination. In moist apparatus the tubes are often burst at the beginning of the experiment.

Titration of Œoline and of Œnotannin in Wines.—F. Jean.—The author finds that œoline and œnotannin are the sole constituents of wine which act upon the solution of iodine mentioned in his memoir on the titration of tannin communicated to the Academy in 1876. It is well, however, to check the results obtained by titration by a colorimetric test made comparatively with a solution of œnoline containing the quantity of this substance indicated by titration. The natural tannin of wine, derived from the seeds and stalks of the grape, gives a greenish black colouration with ferric chloride.

Moniteur Scientifique, Quesneville. October, 1881.

M. Pasteur at the International Medical Congress at London.—A brief notice of the sessions devoted to the question of microbia in reference to disease.

The Congress of Electricians.—An account of the inaugural speech of M. Cochery, with a notice of the representative deputations of different countries, and a general programme of the Exhibition.

Diseases of the Skin in Infancy and Old Age.—A purely medical paper.

Observations on Gums, Resins, and Waxes.—C. G. Warnford Lock.—A translation from the *Journal of the Society of Arts.*

The Resins of the Xanthorrhœa.—J. M. Maisch.—From the *American Journal of Pharmacy.*

Studies on the Alkaloids.—Dr. W. Kœnigs.

A Compiled Account of Cinchonine and Quinine.

Official Reports on the Universal Exhibition of 1878.—The first part of this report treats of pharmacy in France and abroad. The second part is devoted to soaps and stearine. The author remarks that for the preparation of stearine fatty bodies are treated by one of the two following methods:—Saponification with lime under pressure, either with or without agitation, in autoclaves of iron or copper, and without distillation; or saponification with an acid either with or without subsequent distillation. Then follows a description of the mottled soaps made at Marseille and in other parts of France; of the colourless Marseille soap, and the oleic acid soaps. An account of mineral colours is chiefly devoted to ultramarine in its various forms, followed by short notices of vermillion, Prussian blue, and of green, yellow, and black pigments.

Determination of Potash in Agricultural Substances by means of Perchloric Acid.—Armand Bertrand.—In the first place it is necessary to examine if the substance in question contains an ammoniacal salt. If this is the case the ammonia must be expelled by boiling with a little caustic lime. It is necessary that the substance should be perfectly clear. The filtered solution of the sample is evaporated on the water-bath in a small porcelain capsule with 5 c.c. of perchloric acid at 45° B. until the volume of the liquid is reduced to about 10 c.c. The capsule is taken off the water-bath, alcohol at 95 per cent is added; it is let cool, and the potassium perchlorate is collected upon a small filter. The precipitate is washed with alcohol at 95 per cent containing 10 per cent by volume of perchloric acid, until the liquid running through no longer shows the reactions of sulphuric and phosphoric acids. The washing is then completed with alcohol at 95 per cent without the admixture of perchloric acid. It is then dried in the stove. At the end of twenty to thirty minutes the precipitate is detached from the filter and spread out in a tared watch-glass. It is weighed twice, to be certain that the desiccation is complete, and the weight of the potassium perchlorate thus obtained is noted. On the other hand, as there always remains a little perchlorate adhering to the filter, instead of using a tared filter, the author considers it more expeditious to operate as follows:—During the desiccation of the perchlorate in the watch-glass the filter is burnt in a platinum capsule fitted with a lid. The potassium chloride resulting from the calcination is washed into a glass, and the chlorine is determined with a centinormal silver solution. A multiplication indicates the perchlorate to be added to that which has been weighed. This process gives accurate results in presence of lime, magnesia, soda, baryta, iron, alumina, and sulphuric or phosphoric acids, free or combined. The author prepares his perchloric acid as follows:—He dissolves purified barium chlorate in lukewarm water, and precipitates with dilute sulphuric acid. He lets settle, draws off the clear liquid with a syphon, and washes the precipitate of barium sulphate. The solution of chloric acid is evaporated in a porcelain capsule over a naked fire until the concentrated liquid becomes yellow and emits a peculiar sound if heated further. It is then divided in capsules of 19 centimetres in diameter, each capable of containing about 700 c.c., and the evaporation is continued until the liquid is completely colourless, and emits dense white fumes. In order to diminish the inevitable loss of perchloric acid, a little water may be added from time to time during the concentration. Four parts of barium chlorate yield in general 1 part of perchloric acid at 45° B. The colourless liquid is distilled in a retort heated on the sand-bath. A long-necked tubulated receiver is adapted to the retort without the use of a cork.

The Electric Light.—A notice of the various appliances for the electric light on view in the late Exhibition. Mention is made of a lamp with enormous carbons, having an intensity equal to that of 150,000 candles, and proposed for service in lighthouses.

Industrial Preparation of Coniine and its Compounds.—Dr. J. Schorm.—From the *Berichte der Deuts. Chem. Gesellschaft.*

Annales de la Société des Sciences Industrielles de Lyon. No. 2, 1881.

Glycerin as an Agent for the Preservation of Meat and Organic Matter.—H. Danzer.—The author recommends glycerin for the preservation of a great variety of organic substances, both articles of food and even manures. [Will not the rising price of glycerin interfere?—*Ed.* C.N.]

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. October and November, 1881.

These numbers contain no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c., No. 1, July and August, 1881.

The only chemical matter in this number is taken from the *Proceedings* of the Iron and Steel Institute (at their meeting in London, May, 1879) and from *Comptes Rendus*

MISCELLANEOUS.

Society of Arts.—The first meeting of the Applied Chemistry and Physics Section of the Society of Arts will be held on Thursday, January 26th, when a paper by Dr. Thudichum, on "Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of certain Diseases in Animals," will be read, The following papers will be read at subsequent meetings: "Photometric Standards," by Harold Dixon; "Practical Hints on the Manufacture of Gelatin Emulsions and Plates for Photographic Purposes," by W. K. Burton; "Some Practical Aspects of Recent Investigations in Nitrification," by R. Warington; "The Manufacture of Steel from Phosphoric Pig-Iron," by S. G. Thomas and Percy C. Gilchrist.

MEETINGS FOR THE WEEK.

Monday, Jan. 2nd.—London Institution, 5.
Tuesday, 3rd.—Royal Institution, 3. "Jupiter, Saturn, Uranus, Neptune," by Prof. R. S. Ball.
—— Pathological, 8.30. Anniversary.
Thursday, 5th.—Royal Institution, 3. "The Solar System further Considered," by Prof. R. S. Ball.
—— London Institution, 7.
—— Royal Society Club, 6.30.
Friday, 6th.—Geologists' Association, 8.
Saturday, 7th.—Royal Institution, 3. "How we Learn Facts in Astronomy," by Prof. R. S. Ball.

Erratum.—P. 299, col. 1, line 28 from top, after the words "well-fitting cork," *insert* "and 2·5 grms. of finely-powdered zinc oxide added."

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